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Correspondence.—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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BRIEFLY TOLD.

A TIMELY RECOGNITION OF WORK WELL DONE.—A truly fraternal action marked the closing session of the National Commercial Gas Association, which happening took place right after the call to order was spoken the morning of the last day. It may seem a long hark back to mention it here, but our account of it came too late for printing in the JOURNAL of last week. After the regular order had been announced, Mr. Fred. R. Persons, having received recognition from the President, remarked that some people were in the habit of being late, and in connection therewith he would call attention to the fact that Secretary Bigelow had almost caused "a strike" amongst the delegates through his having been "repeatedly" late. The speaker then advanced towards the Secretary and tendered to him a handsome gold watch of the repeater type, to the ring of which was affixed a chain of gold and platina, the chain also helping to hold while it dangled an artistic gold pencil of the reporter's type. Friend Bigelow, quick, snappy talker that he is, was quite voiceless for the time being, but after a rally he managed to blurt out his thanks for the tokens of their esteem and approval so unexpectedly bestowed upon him. He did manage to get in one characteristic sentence in his acknowledgment when remarking that he hoped that the time would be well put to use did they allow him to speedily dull the pencil point through writing down the names and addresses of those applying for membership in 1908; and closed by saying that the splendid attendance registered and excellent technical work done during the convention were true recompenses for the hours of planning and work that had been given by those who projected the Association and who proposed to carry it onward and upward. The giving and the receiving were both of a happy order.

DEATH OF EX-GOVERNOR SAWYER.—A career that was noted for steadfastness, integrity and success was brought to an end when death claimed Charles Henry Sawyer the morning of the 18th inst., at his home in Dover, N. H. Deceased was born in Waterford, N. Y., March 30, 1840, and when 10 years of age he went with his parents to Dover, N. H., where his father established a woollen mill, the fame of which eventually became world wide. Having acquired a common school education he entered his father's employment and took every step in mill work, from that of bobbin boy to President—the modest mill eventually grew into the huge Sawyer incorporation. Active and ambitious politics attracted him, and the people of Dover honored him with promotion. His course eventually became such as to cause the people of the State to advance him. He served in the New Hampshire House of Representatives for 4 terms; in 1881 he was a member of Governor Bell's staff, and in 1886 the people elected him their Governor. Perhaps this tribute from the pen of a biographer who knew him well will best show the way in which he was held by his contemporaries: "He served in the high office of Governor with conspicuous fidelity to the dictates of his conscience and with scrupulous regard for the interests of the State, retiring with a record for diligence, honor and sagacity that places him amongst the noblest of New Hampshire's rulers." He was prominent in the management of the Dover Gas Light Company, and one of his intimates was that well loved one of the fraternity, the late Hon. A. M. Norton, of Nashua. Deceased was of course prominent in all that belonged to the civic, commercial, religious and social life of Dover and of the State, and his memory is that of one whose life's work was well wrought. He is survived by four sons and a daughter.

A GAS ASSOCIATION FOR INDIANA.—A tentative meeting of the gas and electric men of Indiana was held in the Claypool Hotel, Indianapolis, the 16th inst., at which it was decided to organize the Indiana Gas and Electric Association; but it was also agreed not to name permanent officers, until the Committee (Mr. S. Murdock, of Lafayette, Chairman) appointed to counsel with the Managers of other Companies throughout the State, not present at the meeting, had reported.

LIBRARY OF CONGRESS JAN 27 1908 SMITHSONIAN DEPOSIT.

The proceedings at Indianapolis indicated that there will be plenty of vitality in the new Association. The initiative in this movement was taken by Mr. James W. Dunbar, of New Albany, Ind., and he presided at the New Albany assembly, Mr. Frank K. Lane, of Richmond, acting as Secretary.

CURRENT COMMENT.—

MR. M. H. CUTCHEON, Manager of the Houghton County Gas Company, of Hancock, Mich., has succeeded Mr. Roderick Mackenzie as Manager of the Marquette Gas Light Company, of Marquette, Mich. Mr. Cutcheon will in the future manage both properties for William and Sinclair Mainland, of Oshkosh, Wis. Mr. H. J. Waterbury has been appointed Assistant Manager of the Marquette Company.

THE election for Trustees of the Engineers' Club, of New York, this year was notable for the fact that it was the first in its history when two tickets were in the field. The successful (administration) ticket bore the names of W. H. White, Jr., G. E. Weed, G. W. McNulty, A. C. Humphreys and A. W. Kiddle. That the Club is in excellent condition is well shown by the figures in the report of the Board of Managers, which show a balance to credit of quite on to $39,000.

MR. FREDERICK J. MAYER, General Manager of the Didier-March Company in America, sailed for Europe, per steamer Kronzprinzessen Cecilie, last Tuesday. His departure, which was hurriedly determined upon, was occasioned by some very important developments in connection with the Dessau system of vertical retort benches, the patents for which in this country are controlled by him. Many improvements in the vertical plan of construction have been recently made, and the results attained in its working have been so pronounced that, as a going principle, it is bound to command widespread attention from manufacturers of coal gas. The American division of the Didier-March Company—the mention of Mr. Mayer's name recalls this fact—has already secured a large share of business, several very important contracts having been closed since the first of the year. The task of getting ready the factories, which was really a large undertaking, has been completed, and Manager Mayer and his men now announce their ability to take on and carry out orders of any magnitude right on the times specified in the contracts.

WE are informed by the Laclede-Christy Clay Products Company, of St. Louis, that Mr. Leigh Wickham has entered their employ. Mr. Wickham will represent the Laclede-Christy Company amongst the gas men generally, and he will also, in connection with Mr. Roger W. Polk, the Company's Gas Engineer, give close attention to the gas plant branch of the Company's business.

ON January 7th Mr. Johnston introduced in the New York Assembly an "Act in relation to illuminating gas of the city of New York and regulating the quality and pressure thereof and the price to consumers other than said city. Penalties are provided for violations." It was read once and referred to the Committee on Electricity, Gas and Water Supply. Prices sought to be established: For the Borough of Manhattan, Borough of Brooklyn—except 30th and 31st Wards—Borough of Bronx—except portion of old town of West Chester, outside Wakefield and Williamsbridge—and the First Ward, Borough of Queens, 85 cents per 1,000 cubic feet; Brooklyn, $1 per 1,000 cubic feet; for 31st Ward, Borough of Brooklyn, portion of Borough of Bronx, Borough of Richmond and Third Ward, Borough of Queens, during 1908, $1.15 per 1,000; 1909, $1.10 per 1,000; 1910, $1.05 per 1,000, and $1 per 1,000 thereafter. Standards for illuminating value and purity quite like those now prescribed are also specified in the bill.

"C. L. R.," writing under the 20th inst., from Elgin, Ills., says: "I am sorry to inform you that Mr. C. B. Strohn, District Manager of the Western United Gas and Electric Company, underwent a very serious operation, at the St. Charles Hospital, Aurora, Ills., the even- of the 15th inst.; and I am happy to add that he is improving rapidly. Mr. C. D. Slimpin, Chief Clerk of the Elgin office, is in charge of the Elgin district during the absence of Mr. Strohn."

MR. N. P. NELSON, of Rockford, Ills., has been appointed Receiver of the Illinois Light and Fuel Company, subsequent to a petition in involuntary bankruptcy, filed by that concern. Its business was the manufacture of gas and gasoline engines.

THE City Trustees of Hermosa, Cal., have under consideration a proposition from the Watson Construction Company, under which the latter agrees to construct a gas plant of the water gas type, up to a daily production of 120,000 cubic feet for the sum of $24,000. This proposition also includes the placing of 7 miles of cast iron mains. Taken all-in-all this proposition looks a loose one, for the main item should come near to costing the sum named.

[Continued from page 101.]

PROCEEDINGS AMERICAN GAS INSTITUTE, SECOND ANNUAL MEETING, HELD AT THE NEW WILLARD HOTEL, WASHINGTON, D. C., OCTOBER 16, 17 AND 18, 1907.

SECOND DAY—MORNING SESSION.

The President—We will now have the

REPORT OF THE COMMITTEE ON ELECTROLYSIS.

Mr. Glasgow—I asked the President to call for the Report of the Electrolysis Committee as soon as Prof. Ganz had finished his lecture, because this lecture is in fact the report of your Committee for this present year. You must not fear that every year we shall inflict upon you a report like that of 1906, of some 173 pages. On the contrary, we shall trouble you with a report only when we have something to say. We think you will all now agree that, if your Committee did nothing else to justify its existence, it has done yeoman's service to this Institute in securing Prof. Ganz as its Consulting Engineer and in starting him in the electrolysis business. I should like anyone who has any suggestion or criticism to offer to state it freely now, while the Professor is still with us. He will be happy to answer any questions or meet any criticisms that the individual members of this Institute may wish to offer. I may add that our relations with the Chairman of the German Gas and Water Association continue very cordial. We are not blessed as they are with a considerable annual appropriation for investigations into electrolysis, but we are generously allowed the benefit of their conclusions; and we have recently entered into correspondence with the French and British Institutes looking to the appointment of co-operative committees by them. Manifestly, if our Institute and these three European sister institutions can all work in concert in this matter, it will be far more beneficial than if each one of us works alone. In conclusion let me say that when we distributed our original report, some 6 months before the 1906 meeting, we invited communications from the members rela tive thereto; but not a single communication or suggestion of any sort was made. Now I submit that a committee of this nature, of an Institute of this character, has the right to expect that the individual members will take a keen and active interest in the work and communicate any facts or information that will add practical value to the conclusions. If, on the other hand, anybody has been nursing any discontent with our last report now is the time to ventilate it; for your Committee sees nothing to change therein, and at present has nothing to add thereto. We hope, however, that in the reasonably near future we shall be able to substantiate our conclusions to such an extent that we shall feel justified in inviting some undertaking to test them in a court of law with every prospect of success.

Mr. Donahue—I move that the Committee on Electrolysis be discharged with the thanks of the Institute. [Seconded.]

Discussion.

The President—Is there any discussion on this statement made by Mr. Glasgow?

Mr. A. S. Miller—I am not going to let my dear friend from "dear old Lunnon" back me down. It has been some time since I read this report, and I do not know whether I remember it correctly or not, but my best recollection is that the conclusion of the committee then was that the only thing to do was to put in a double trolley. Is that it?

Mr. Glasgow—Yes.

Mr. A. S. Miller—That was my best recollection, that they came to the conclusion that the only absolute safety lay in the double trolley. We have to take conditions as we find them. The question that the gas man has had to decide, when he has found stray currents on the pipes, was what to do about it. I have for a number of years advocated bonding, notwithstanding that Prof. Ganz of this committee thought that such a remedy was radically wrong, but I have not felt it possible to go into a court of law with the idea of making the railroad reconstruct its whole system when it could, for a very small expenditure, comparatively speaking, adopt an efficient remedy by bonding. I did not feel that there was anything for us to do but to bond. When a system of piping is bonded, it does not necessarily mean that you must simply tie in a few places of high potential, but you must make a careful survey, as Prof. Ganz says, of the whole system to determine the danger points. It is necessary to survey the water pipes, cables and all other underground structures in the neighborbood and to extend the return feeders far enough from the

generating or sub-stations to prevent an excessive flow of current through any particular pipe or cable. It is also necessary to bond to the proper returns all of the underground structures in the immediate vicinity. Such underground structures can be bonded so as to practically prevent electrolysis, and this has been done in at least two cities to my knowledge. I do not say that the double trolley would not be better, but so far it has been commercially impossible to compel the railroad companies to change to the double trolley system.

Mr D. McDonald (Louisville)—I am sorry to hear that statement made before this Institute, because if any one of you ever has a lawsuit with a street railroad Mr. Miller's remarks will be read verbatim to the jury, as showing that this difficulty with electrolysis can be overcome by bonding. We had that out pretty thoroughly last year, and it was the opinion of this whole Association that, as soon as the stray currents were turned loose, there was bound to be mischief, and that there was nothing that a gas company could do to protect itself. I think the fact is that you can, to some extent, localize or minimize the trouble by the bonding that Mr. Miller advocates, but in the case of cast iron pipe with lead joints, or at some of the fittings in wrought iron screw pipe, you are bound to have trouble wherever the current leaves the pipe or leaps across any gap in the continuous conductor.

Mr. H. L. Doherty—In common with Mr. McDonald, I am sorry to see anything go on the record here which is prone to aggravate the trouble in any way. I do not want to make any remarks myself, but I do not think that the double trolley is necessary in most cities, and yet I do believe there are conditions where it is almost imperative. I did not read last year the Report of the Committee on Electrolysis, and I was not present when it was discussed, but I have listened to the lecture by Prof. Ganz with a great deal of interest, and personally I want to pay tribute to his ability on this subject. I think he discloses some rather startling errors that have cost the water and gas companies of this country a great deal of money and a great deal of trouble. Personally, I do not think there is any general rule that can be laid down regarding how a system should be arranged to prevent electrolytical action, but I know I have tried to get some sort of a rule to go by, and the only rule that I ever evolved was one that sounded so simple that it seemed almost foolish, yet I believe that rule has saved us a great deal of money and has helped to do our work properly. The rule is simply *that the arrangement must be such as to prevent the current from leaving the pipe through an electrolyte.* If you plan what you are going to do, and if you will measure it by that rule, you will find you have produced the condition you want. Prof. Ganz's remarks on the need of simultaneous observations is another thing which I think will bear reiteration. The measurements that are made by one group of observers, at different hours of the day upon different days and under different conditions of soil, I think sometimes are apt to be so misleading that you are worse off with them than if you did not have them at all. Now, there has been a general feeling that bonding was the proper thing to do, but at the same time it always seemed to me that bonding at the power house would tend to generalize your trouble rather than to localize it, and if I must have electrolytic action I prefer to have all of that action take place at one spot, if possible, where I can anticipate the trouble. Several other points in Prof. Ganz's lecture, I think, we can well afford to lay great emphasis on. One is the difference in potential. While he made it very clear that there is no such thing as being able to determine the action by the difference in electromotive force, I still think that that particular point, in view of the common error that prevails, should be more definitely emphasized. It is the point where you get the small difference of potential where your trouble is apt to occur. It is also the belief of most gas men that the most perfect system of bonding on the part of a street railway company would be the most perfect protection, but there are often cases where bad bonding at certain portions would be advantageous. I might cite an example of a line going out through perfectly dry soil, then going through a swamp and into another portion of dry soil. Now, if you destroy the railway company's bond at the point of leaving the dry ground and go into the swamp and depend on all the current going to your pipe in the damp ground at that point and going off through the metallic bond at some other point, you would very ltkely be free from electrolytic action from that particular current. In general I believe that bonding of pipes to rails is about the most dangerous thing that can be done, but when it is going to be done it should be done by a man who thoroughly understands the problem. Outside, probably, of the work which has been done by our Committee on Electrolysis—and I wish, so far as that is concerned, to express my admiration for Mr. Glasgow and the Committee—I think it would be a good thing for the gas men of the country if all the previous literature that I have seen on this subject, with the exception of the address of Mr. Bump, before the Western Association, was burned up.

Mr. Bump—May I add a few words to this discussion. I think the man who advocates a system of insulated joints has been somewhat neglected, though the derivation of benefit therefrom is nearly always considerable if they are intelligently installed. We have gas men who say that they do not care whether the water company goes ahead and bonds or not; in fact, I have heard that statement made Now it is a well-known fact that there is a constant interchange of current between the water pipes and gas mains. Take the ordinary system, with 1,000 or more water heaters, where we have a metallic connection between the two systems, and it is apparent that what one does must affect the other even if there were no interchange of current through the earth. Recently another factor that has entered into this problem is the adoption of the alternating current system for traction work, which I believe is going to be the ultimate solution. The progress of this system will be slow in the large cities, but it is already coming in, and will progress more in the cities in the future. I believe that the solution of our trouble will lie in the adoption of some such system as that. Bearing on the question of the electrolytic effect of alternating current on the pipes, a paper was presented before the American Institute of Electrical Engineers, in which it was proven that the damage by electrolysis is reduced to a fraction of a per cent., which makes the damage so small that it would be almost impossible to distinguish between it and natural corrosion.

Mr. H. L. Doherty—Before this discussion is closed I would like to add just one word by stating that what we want, as it seems to me, is a practical check valve for electricity, so that when we make a bond we will not only make one that will take the current off the pipes but that will also make a bond that will not take it on. What we want is a practical, commercial check-valve that will allow the current to go off the pipe but not let it go on. I have felt that the bonding of a street railway system where we had an immense number of water connections was apt to be an advantage to us, although I would defer to Mr. Bump's judgment on that. Where the water company has thoroughly bonded its system, and we have a number of metallic conductors, the action in a city where they use cement joints would be that any current entering our pipes would be apt to go back and take a path on the water main.

Prof. Ganz—I have just jotted down a few notes. In regard to the significance of potential differences as an indication of electrolysis or of current, I agree thoroughly with what has been said. I think that is also borne out in my written lecture, and perhaps better than in what I have said this afternoon. I think some one has also said that the two cities, to which Mr. Miller referred, were bonded by him. That is probably why they have developed little trouble. I cannot deny that if you run a large return conductor from the negative busbar to every positive pipe of your system, and maintain every pipe negative, that then the system will be safe. If, however, you have a condition such as I showed on the board this afternoon, or such as I have here in the diagram, where four times during the day the current at one point in the system changes in direction, then the points at which the bonds would have to be applied would also change, so that it would be practically impossible to bond successfully. It was also said that the solution of the problem will be the use of alternating current. I do not think that this is necessarily so. I agree that laboratory experiments have been conducted which show that with alternating current the electrolysis is only up to 2 per cent. of that produced by an equivalent direct current; but we have no practical experience with alternating current roads. Alternating current will produce electrolysis, not only where the current leaves the pipe but where it enters the pipe, and I am not so sure that a piping system is going to be safe even if the alternating current should be adopted, for all neighboring electric roads; this is still a long way off. I think that is all I care to say.

The President—There is a motion before the house. It has been moved and seconded that the Committee on Electrolysis be discharged with thanks, and that the whole matter be referred to the Technical Committee. Are you ready for the question? [Adopted.] The time for adjournment is passed, and we will take up the first thing in the morning whatever committee reports have not yet received attention.

Third Day—Morning Session.

The Institute was called to order at 10 A. M., by President Clark,

who said: The Chair has two committees to name under authority of the Constitution. On the Public Relations Committee the Chair has done what some may criticise in putting his own name on the list of members of that Committee.

Dr. Humphreys—I will explain that fully. This Committee will have to do a great deal of work, and I particularly requested the President that he put himself on that Committee. The President is familiar with a great many of the matters which necessarily will come before that Committee, and I think it is essential that he should be a member of it.

NAMING THE PUBLIC RELATIONS AND TECHNICAL COMMITTEES.

The President—On the Public Relations Committee I have appointed Messrs. E. G. Cowdery, Chairman; I. C. Copley, C. F. Prichard, John Gribbel, Donald McDonald, of Louisville, and Walton Clark. On the Technical Committee, Messrs. W. H. Gartley, Chairman; Alten S. Miller, W. A. Baehr, W. E. McKay, R. B. Brown and A. G. Glasgow. The next business is the report of the Committee on "Bureau of Information," by Mr. Gartley.

REPORT OF THE BUREAU OF INFORMATION.

Mr. Gartley—I have a report for the Committee which can be turned in. I will read the questions (there are only eight) without giving the answers, because the questions will give you some idea of the scope of the Bureau's work as so far conducted, and allow you to judge whether it is better to continue the work or not.

The Bureau of Information, having received notice of their appointment on April 22d, 1907, wish to report that, up to September 30th, 1907, eight questions (the eighth's answer not yet prepared) have been referred to them. These questions show a tendency towards the elementary facts connected with the gas business.

It is apparent that the members of the American Gas Institute are slow to avail themselves of this source of information, but it is believed by the Bureau that, judging from the nature of the questions submitted, it would be worth while to continue the experiment of operating such a Bureau for at least a year longer.

In compiling the answers to the questions submitted, the members of the Bureau believe that, before the answer is sent to the inquirer, it should be passed upon by every member, and that, in order to save time, the Chairman of the Bureau should receive the question direct from the inquirer, instead of having it sent to the Secretary of the Institute.

The inquirer should not expect to receive a fully considered reply within a month or 6 weeks from the date of the question.

The Bureau recommend that the questions (the name of the questioner being withheld) with their answers be published in the "Proceedings," but that the Bureau exercise its discretion as to omitting any answer that partakes of a personal or advestising nature.

Question No. 1.—We are operating a small gas plant, sending out about 35,000 cubic feet daily, and are experiencing great difficulty from naphthaline at a point about 700 feet from our works. The plant is located at a point about 20 feet lower than the main where the difficulty occurs. We have been removing the naphthaline by naphtha. The main is 8 inches. Kindly inform me the best manner of thoroughly cleaning the pipe at that point?

Answer.—From the above it is supposed that your trouble is a recurring one, which means that you are still making naphthaline at the works, in which case any temporary remedy will only give temporary results. It would, therefore, be advisable to take such steps as will eliminate the sending out of naphthaline from the works. In order to clear the main at present, I would suggest that you take pressures with a water gauge, at points from 100 to 200 feet apart, and determine just where the largest drop in pressure occurs. This point would indicate the greatest stoppage. At the first opening from the works inject into the main 87° gasoline at the rate of about ½ pint per 1,000 cubic feet of gas during the period of peak load. Repeat this procedure until the pressure gauges show no abnormal drop in pressure. As 87° gasoline is very volatile, it must be used with the utmost care and should be used only by experienced men. If these are not available, it would be better to use a lower grade or a less volatile gasoline. The solvent may also be introduced immediately after the street main governor; but it is safest to use it in the open air. For further information on this subject, please see Question Box, Ohio Gas Light Association, 1905; pages 111, 184, 201, 208, 209, 270 and 293. Also see paper on "Prevention of Naphthaline Stoppages," by Mr. Paul Doty, before the Western Gas Light Association, in AMERICAN GAS LIGHT JOURNAL, June 26, 1899, page 967.

Any hydrocarbon oil, alcohol, and some others, are solvents for naphthaline. Some of these will add to and others take from the illuminating value of the gas. Some manufacturers prepare an oil called "Naphthaline Solvent," containing a mixture that will not affect the gas. Any oil used, of course, should be free from naphthaline.

Question No. 2.—Can gas coal shipped from the Pittsburgh region be stored out of doors without danger of spontaneous combustion in piles 20 feet high? If it is not considered safe to store it in piles of this height, would the danger of spontaneous combustion be eliminated if the coal was roofed?

Answer.—Spontaneous combustion in coal from the Pittsburgh region piled in piles 20 feet high, out of doors, is extremely unlikely to occur, but it has occurred. It has also occurred when piled in sheds.

References.

"Fire Risks and Fire Extinction."

"The Spontaneous Ignition of Coal," *Journal of Gas Lighting*, April 3, 1906, page 33.

"Question Box," New England Association of Gas Engineers. AMERICAN GAS LIGHT JOURNAL, March 7, 1904.

Ohio Gas Association; "Question Box," 1905, pages 10 and 11.

"Proceedings" of the American Gas Institute; Vol. 1, 1906; Practical Class, Section of 1909, pages 264, 265, 266.

Journal of Gas Lighting, March, 1900, Address of President; Southern District Association of Gas Engineers and Managers.

AMERICAN GAS LIGHT JOURNAL, Dec. 18, 1899, page 977; "The Combustibility of Coals," by Mr. O. Lang.

Journal of Gas Lighting, January 1, 1901, page 26. Short note on some causes of spontaneous combustion of coal.

Question No. 3.—We are considering the advisability of furnishing an adjoining town with high pressure gas. It is 8 miles away and is divided into 3 small villages. Our gas mains would parallel an electric road all the way. The population of the district is about 4,000. We estimate that we can get 500 customers in 5 years. The price of gas to start with will be $1.25 net. The estimated maximum hourly consumption will not exceed 3,000 cubic feet in 3 years, and 4,000 cubic feet in 5 years.

a. What size pipe had we better run?

b. How deep should this pipe be laid?

c. Should this pipe be laid with or without insulating joints, and if with insulating joints, how often?

d. Is it better to distribute by district governors to low pressure mains in the 3 villages, or by high pressure only?

e. At the generating plant, is it better to put in two Westinghouse air compressors with governors, for automatic action between certain limits of pressure, or horizontal Rand compressors in duplicate; same governor arrangement?

f. To how many pounds can I compress without reducing the candle power? I make ¾ coal gas and ¼ water gas.

Answer.—"a." What size pipe had we better run? Reference should be made to answer to questions d and f, covering initial and final pressures on this proposed pipe line. The Pittsburgh formula for high pressure transmission will be found satisfactory in determining the amount of gas that will be transmitted through any size of pipe constituting this pipe line and between the pressures determined upon. It is not stated whether there will be any further expansion of business after 5 years, or whether there is any possibility of a further extension of this pipe line. With the facts given, the minimum size sufficient for this installation is 2½ inches, with which size pipe this pipe line will supply 4,000 cubic feet per hour with an initial pressure of 20 pounds gauge, and a final pressure of 10 pounds gauge. At 30 pounds initial pressure it will supply 6,000 cubic feet per hour. If this can be considered satisfactory it will be advisable to install a compression storage tank of moderate capacity at the end of this pipe line, and as near the center of the distributing system as possible, in order to steady the pumping conditions which will otherwise be irregular with a line of such small storage capacity, and to safeguard the gas supply during any repairs which may hereafter become necessary on this pipe line. It may also be borne in mind that this storage at the end of the line will increase the peak load delivery capacity of the line. This pipe line so equipped will be found entirely satisfactory. If there be other conditions, however, with regard to which the next larger size of pipe may be considered advisable at a greater investment cost, storage at the end of the line may be dispensed with, for a time at least. The cost of compression tank may be roughly estimated at $500, which is

here stated in order to facilitate the estimate by the inquirer as to the relative cost of these two pipe lines. There will be practically no difference in pumping cost as between the two sizes.

b. "How deep should this pipe be laid?" This pipe should be laid with the top of the pipe from 2 feet 6 inches to 3 inches below the surface of the ground.

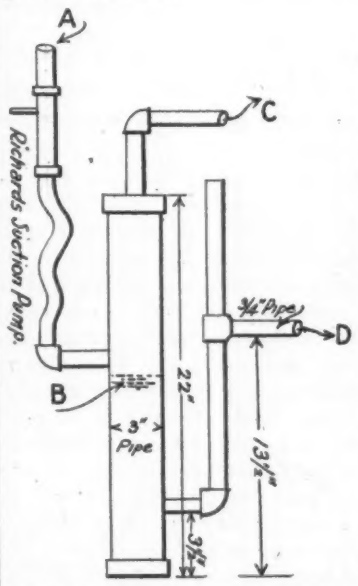
c. "Should this pipe be laid with or without insulating joints, and if with insulating joints, how often?" There is much difference of opinion among engineers as to the value of the insulating joints on pipe lines laid in the ground. It is clear that they will diminish the amount of electricity flowing in a pipe only when the electric current cannot jump through the ground around the joints, and that in case of such leakage they are a source of danger. Following the satisfactory experience on a line that has been in for many years, and which similarly parallels an electric traction line, it is rather suggested for safeguarding this proposed line that it be laid 10 inches or more, if possible, from the nearest street car rail; that wherever it may cross under the rails it be protected under the rails, and for at least 10 feet on each side of the rails, by inclosing it in a box filled with pitch or other non-conducting material; that wherever the distributing mains and services supplied by it cross under the street railway track they be insulated in the same manner. Under these conditions electric currents should not be found on this pipe, unless the soil conditions are extremely favorable to them. In case they are found on this line even after such precautions, insulating joints may be put in gradually, beginning with one at each end of the pipe line, the pipe to be insulated from the ground for a considerable distance on each side of the joint. Surveys following each addition will determine whether or not the joints are of value and how many must finally be placed in the line under these conditions.

d. "Is it better to distribute by district governors to low pressure mains in the three villages or by high pressure only?" A consideration of the formula for high pressure transmission will serve to show that, for a given transmission line and given delivery of gas, any increase in initial pressure develops a much more considerable increase in terminal pressure. If a given line is delivering gas at a terminal pressure of 2 to 5 pounds gauge pressure, it can be made to deliver the same amount of gas at from 5 to 10 pounds pressure by very slightly increasing the initial pressure. It follows, therefore, that direct high pressure distribution entails no increase in the size of the transmission lines, and practically no increase in the pumping cost. On the other hand, there is a very great saving between the cost of a high pressure distributing system and that of a low pressure distributing system. The question is wholly, therefore, one of safety and satisfaction. With the ordinary small country towns there can be no question as to the safety of a high pressure distributing system as far as the underground mains and services are concerned, while for any community there is to-day no question as to the safety and satisfaction of a high pressure distributing system as far as the supply to any individual consumer is concerned. In this particular case, a high pressure distributing system is recommended.

e. "At the generating plant, is it better to put in two Westinghouse air compressors with governors, for automatic action between certain limits of pressure, or horizontal Rand compressors in duplicate, same governor arrangement?" The proper compressor for this installation is the simple straight line compressor with flywheel. There are several good makes of this style of compressor. The value of automatic devices is a question on which opinions differ, and on which an answer must be largely a matter of personal opinion. In this class of devices we include whistles and other alarms on boilers, etc. Many engineers do not believe in devices of this nature on which men come to depend, but which, some day, may fail in action. If such a device, however, is desired, a bell alarm will probably be found most satisfactory, as giving notice in all cases to the man in charge of the plant when the compressor man has failed in his duty. A recording pressure gauge should be maintained at both ends of the line as a continual check on the pressure carried.

f. "To how many pounds can I compress without reducing the candle power? I make ¾ coal gas and ¼ water gas?" Compression cannot probably be carried beyond 5 pounds gauge pressure, without some effect on the candle power as measured by the photometer. A gauge pressure of 20 pounds, however, will effect no practical impairment of this gas in value to the consumer and occasional pressures of 30 pounds will likewise not be of moment to the consumer. Up to 30 pounds gauge pressure this gas, as burned in Welsbach mantles, will not, as far as the facts are known at present, be impaired at all in efficiency and this naturally includes all fuel consumption.

Question No. 4.—"Can you inform me what is the most practicable and inexpensive blast for laboratory use where water pressure and gas are accessible?"



Sketch of Laboratory Air Blast.—*A*, Connection to water supply. *B*, Water line. *C*, Compressed air discharge. *D*, Water overflow to sink.

Answer.—The most inexpensive and all-round satisfactory blast for laboratory use is probably the one devised by Prof. Richards, of the Massachusetts Institute of Technology. It consists of a suction pump, the outlet of which is connected to a receiver that serves to separate the air from the water and deliver the former under pressure. This apparatus is listed by Messrs. Eimer & Amend, New York city, and Bausch & Lamb Optical Company, of Rochester, N. Y., and is quoted at about $6.50 complete. To increase the volume of the blast two or more suction pumps can be connected to the separating cylinders.

Question No. 5.—"What is the chief reason for the common practice in gasholder building of having both an inlet and an outlet pipe, or is there any objection to operating a gas plant with the holder and main system in parallel?"

Answer.—There are four reasons for having both an inlet and outlet pipe.

First.—To average the candle power of the gas sent out to the consumer. Except in the larger works, the candle power of the gas as made fluctuates throughout the hour. If the holder holds the make of several hours, a candle power of a better average is sent to the consumer.

Second.—To permit the gas to cool before going to the governor, thereby preventing the heavy deposits of drip oil and water, particularly in the winter time.

Third.—To permit the gas coming to nearly a quiescent state in the holder and permit the dropping out of the gas in that condition of certain mixtures of heavy hydrocarbons and tar, which, if deposited in the mains at low temperatures, would seriously influence the candle power.

Fourth.—To insure against the putting of the holder out of commission by reason of one pipe being stopped up with naphthaline or leakage.

Question No. 6.—In accordance with the decision of the Bureau, as expressed above in this report, this question and answer have been omitted.

Question No. 7.—"Can you give me explicit directions (or refer me to some article that will) for finishing off brass goods in the rich gilt finish as seen on the best grade of gas and electric fixtures?"

Answer.—The best types of gas and electric fixtures are first polished on a buffing machine and then dipped in a preparation of lacquer for the purpose of preventing the fixtures from becoming tarnished by sulphur and other compounds. The use of lacquer on gas fixtures also permits the fixtures to be cleaned with soapsuds. The common grades of fixtures are only polished on a buffing machine.

Question No. 8.—As yet unanswered.

Mr. Gartley—Question 6 asked where inquirers could purchase certain forms of fixtures, and it is to be answered, but is not incorporated in the report. This is one of the questions which the Committee did not think should be published in the report as it might work some injustice to manufacturers or houses that furnish material who might have been overlooked by members of the Committee whose business it was to answer the question. The answer to No. 8 is not here as the answer has not been criticized by all the members of the Committee. It is a much more complicated question than some of you may think.

Discussion.

The President—The report of the Bureau of Information is before you. What disposition will be made of it?

Mr. A. E. Forstall—I move that the report of the Bureau be received, published in the "Proceedings" of the Institute, that the Committee be discharged with thanks, and that the matter of the continuation of the work be referred to the Technical Committee. [Seconded and adopted.]

The President—The next business is the report of the Board of Revision of the Question Box on Manufacture of Gas.

REPORT OF BOARD OF REVISION OF QUESTION BOX ON MANUFACTURE OF GAS.

Mr. Shattuck—Your committee took the several Question Box publications of the Ohio Gas Light Association and classified and reshaped these answers, supplementing them with additional matter gathered from the American Gas Light Association's Practical Class questions, with some other sources of information. We had this work completed about the middle of September, when we received a large package from Dr. Harrop, of Rio Janeiro, containing a large amount of matter on this subject. This matter was too valuable to be neglected and we are now engaged in incorporating it and rearranging what we have already done, hoping to have it completed in time to have it published in this year's "Proceedings." We recommend that the work we have done be published and bound similar to the work on "Distribution of Gas," and a copy mailed to every member of the Institute, provided our work is not completed in time to go into the "Proceedings." If it is completed in time, extra copies to be furnished by the Secretary, upon request.

The President—That is the whole of the report. Gentlemen, you have heard the report of the Board of Revision of the Question Box on the Manufacture of Gas. What disposition will you make of it?

Mr. Morton—I move that the Committee be discharged with thanks, and that the Board of Directors be authorized at this time to publish it with the forthcoming volume of "Proceedings," but if this is not possible, that the Board be authorized, if they see fit, to publish the report in a separate volume, one copy to be sent to every member, and a supply of copies to be sold at a price to be fixed by the Board, and that the matter of further revision of the Question Box be referred to the Technical Committee.

Mr. W. Forstall—I think before that motion is put we should have an expression of the obligation which we are under to this Committee, for they really stepped into the breach when it was found that the old Board of Revision, owing to the absence of Dr. Harrop, would not be in shape to go on with the work, and some one was needed to carry it on. It did not seem right that the work should be dropped altogether. I think that especial mention should be made of Mr. Stone, because he had done a lot of work on this Committee, after having earned a rest by reason of his labors on the distribution section published last year.

The President put the question and declared the same adopted.

Mr. Stone—Before you pass this by I would like to state that the Committee, in making up the report of the Board of Revision last year, stated that wrought iron pipe was much superior to steel, that it could be worked easier, etc. Investigations conducted by the Committee since then lead them to believe that the statement as made works an injustice, and we would like to suggest that the matter should be more fully investigated before a definite conclusion is reached.

The President—You make that statement, Mr. Stone, with the idea that it should be given to the Chairman of the Technical Committee for his guidance at the time of making up the sub-Committee on the Board of Revision of the Question Box.

(To be Continued.)

Gas Lighting in the Factory.

[A paper read by MR. T. J. LITLE, JR., at the New York Meeting, National Commercial Gas Association.]

The engineering fraternity as a class are interested in any new scheme or device which shows an increased economy. This, however, may be said to apply most forcibly to mechanical and electrical matters. The question of artificial illumination seems to have been considered by them principally from the electrical standpoint. In the past gas has been considered so commonplace that the real significance of the recent great improvements have been overlooked by the engineer.

In this paper I shall take up the question of gas illumination from the standpoint of factory or shop lighting only, for the simple reason that I believe in this particular direction there are great possibilities for development. I do not wish to infer, however, that in other parts of the illuminating field gas cannot be applied with equal success, for investigation will show that in America, as well as abroad, gas lighting is greatly on the increase. This applies not only to interior lighting, but to street lighting as well.

The principal difficulty seems to have been that the engineer has not given the subject the consideration it warrants. If he should study the subject from its logical standpoint—that of comparative cost—many of them would be quite astonished by the comparison, particularly with the electric light.

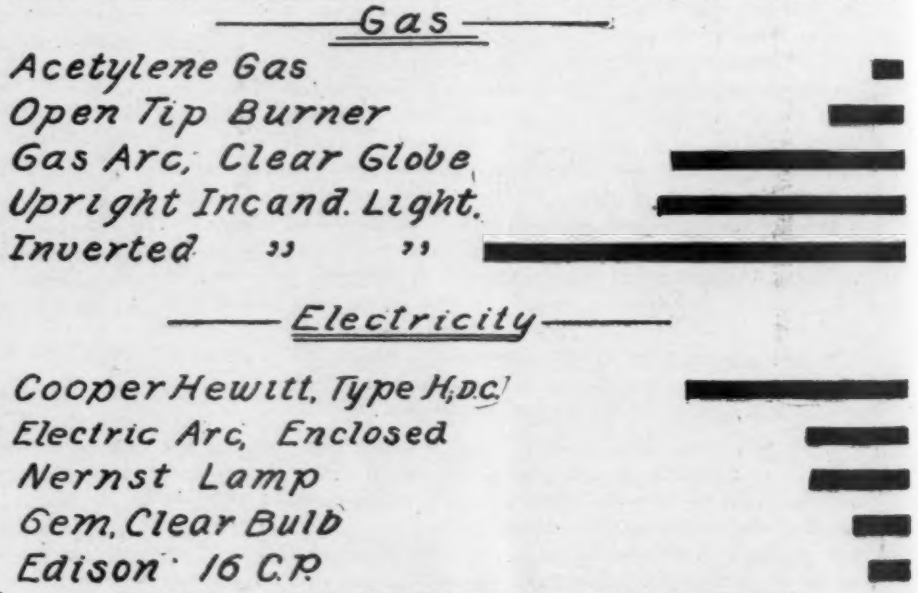
From the power standpoint, any invention which shows increased

GAS

LIGHT	Rate per M. Cu. Ft.	Cu. Ft. Per Hour	Mean L. H. C. P. of Unit	Cost per Hr. of Unit	Quantity for 1 c. Cons.	Quantity for 1 c. M.L.H.C.P.	REFERENCES
Acetylene Gas	$15.00	.5	11.6	$.0075	6.66	15.5	Average of 20 towns Brown's Directory 1907 Practical Illumination, p. 97
Open Tip Burner	1.00	5.0	20.0	.005	10.	40.0	Practical Illumination, p. 79
Gas Arc, Clear Globe	1.00	18.7	244.0	.0188	10.	129.8	Welsbach Testing Laboratory
Upright Mantle, Clear Chimney	1.00	3.7	51.27	.0037	10.	138.5	Practical Illumination, p. 82
Inverted Mantle, Clear Chimney	1.00	3.0	70.6	.003	10.	235.33	Practical Illumination, p. 90

ELECTRICITY

LIGHT	Rate Per Kilo Watt	Watts Per Hour	Mean L. H. C. P. of Unit	Cost Per Hr. of Unit	Quantity for 1 c. Cons.	Quantity for 1 c. M.L.H.C.P.	REFERENCES
Cooper Hewitt	$.10	192	238.96	$.0192	100	124.4	Illuminating Engineer, Vol. 1. p. 449
Enclosed Arc	.10	600	329.05	.060	100	54.84	Practical Illumination, p. 121
Gem, Clear Bulb	.10	125	36.96	.0125	100	29.56	Practical Illumination, p. 42
Nernst, Clear Globe, 3 glower	.10	264	144.26	.0264	100	54.6	Practical Illumination, p. 115
16 C. P. Edison	.10	55	11.68	.0055	100	21.78	Practical Illumination, p. 26



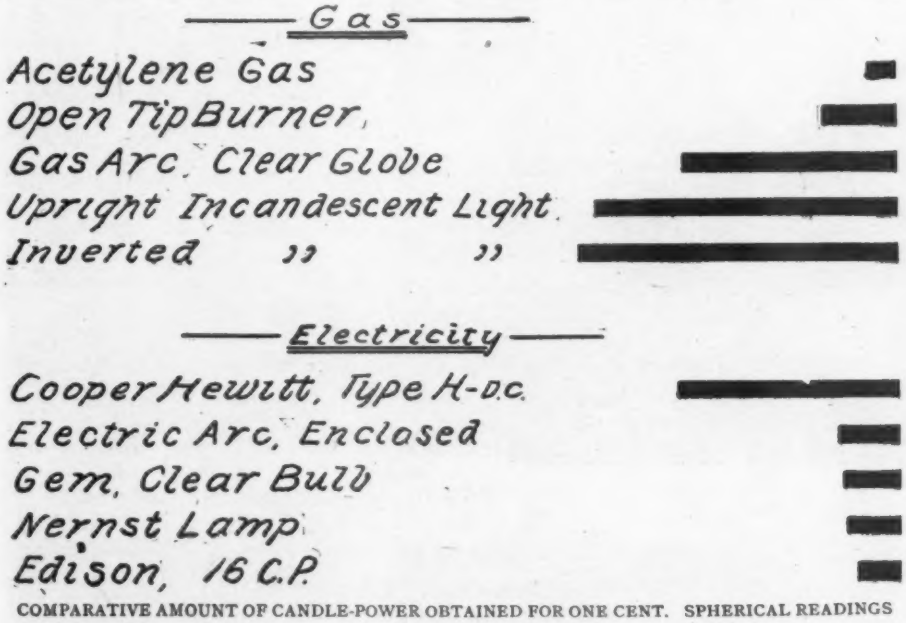
COMPARATIVE AMOUNT OF CANDLE-POWER OBTAINED FOR ONE CENT. LOWER HEMISPHERICAL READINGS.

GAS

LIGHT	Rate Per M. Cu. Ft.	Cu. Ft. per Hour	Mean S. C. P. of Unit	Cost per Hr. of Unit	Quantity for 1 c. Cons.	Quantity for 1 c. M. S. C. P.	REFERENCES
Acetylene Gas	$15.00	.5	12.7	$.0075	6.66	16.9	Average of 20 towns. Brown's Directory 1907 Practical Illumination, p. 97
Open Tip Burner	1.00	5.0	21.0	.005	10.	42.0	Practical Illumination, p. 79
Gas Arc, Clear Globe	1.00	18.8	228.7	.0188	10.	121.6	Welsbach Testing Laboratory
Upright Mantle, Clear Chimney	1.00	3.7	63.0	.0037	10.	170.0	Practical Illumination, p. 82
Inverted Mantle, Clear Chimney	1.00	3.0	54.0	.003	10.	180.0	Practical Illumination, p. 90

ELECTRICITY

LIGHT	Rate Per Kilo Watt	Watts Per Hr.	Mean S. C. P. of Unit	Cost Per Hr. of Unit	Quantity for 1 c. Cons.	Quantity for 1 c. M. S. C. P.	REFERENCES
Cooper Hewitt	$.10	192	238.96	$.0192	100	124.4	Illuminating Engineer Vol. 1, p. 449
Enclosed Arc	.10	600	213.0	.060	100	35.5	Practical Illumination, p. 121
Gem, Clear Bulb	.10	125	40.7	.0125	100	32.56	Practical Illumination, p. 42
Nernst, Clear Globe, 3 glower	.10	264	81.0	.0264	100	30.7	Practical Illumination, p. 115
16 C. P. Edison	10	55	13.2	.0055	100	24.0	Practical Illumination, p. 26



COMPARATIVE AMOUNT OF CANDLE-POWER OBTAINED FOR ONE CENT. SPHERICAL READINGS

economy, such, for instance, as triple and quadruple expansion and condensing engines, as compared with the old type of simple engine, is given the most careful thought by the fraternity, and every engineer knows the state of the art in this direction; but when it comes to matters of illumination very few are prepared offhand to discuss the matter.

There was a time when wood was used exclusively as a fuel. Coal was discovered, but its great value was not recognized because the proper appliances for its consumption had not been invented. The very idea that the black, dense stuff should be considered seriously as a fuel seemed ridiculous. But times have changed and we have lived to see coal used as the world's prime fuel. Why? Simply because it became known that with it more heat could be produced at a given cost than with any other material. The early barriers to its successful adoption were swept away; stoves and furnaces were invented to supersede the old-time open fire-places, and its use for power purposes quickly followed. Gas as a fuel is now looming up prominently.

Passing quickly along we find illuminating gas occupying a very similar field of usefulness. The invention of Dr. Carl Auer von Welsbach paved the way toward the ultimate supremacy of gas as an illuminant. It is now *very* well known that more light can be produced at a given cost with gas than with any other illuminant. The accompanying tables serve to show this graphically.

A campaign of education is necessary in order to bring this forcibly to the attention of the public. The manufacturer would indeed be foolish if he continued to burn wood beneath his boilers when he knew coal was so much cheaper. How about his lighting? Post yourselves carefully on the comparative costs, and impress upon your prospective customer the fact that you are selling light, not gas; that you can deliver the light wherever he wants it, and of such superior quality and so low a cost, that his savings in a single year are in reality extra dividends, which are always thankfully received.

Thousands of factories are being lighted to-day by the incandescent gas system, and the possibilities for the introduction of the inverted burner to machine lighting are going to greatly popularize gas lighting. The inverted mantle is more compact, is better fastened to its carrier, and is consequently stronger than the upright mantle. However, its principal merit lies in the fact that it gives more downward, or useful, light than the upright mantle, and in the shop the burner can be suspended on flexible metallic tubing, attached to inverted swing brackets, which makes it possible for the mechanic to shift the burner for the inspection of his machine or work. The following cuts show a number of successful inverted burners and gas lamps in workshops:

Fig. 1 shows a successful method of lighting a metal-edge, box machine, in a paper box factory, by the use of 2 inverted burners, equipped with angle reflecting shades. This particular machine is extremely hard to light from the fact that the overhanging structure above the working bar makes it impossible to place the lamp directly above the machine. Furthermore, it is equally impossible to place the lamp directly in front of the operator's head, as there is not sufficient space, therefore, the burners are placed on either side. The illumination in this case is perfect. The angle shades completely shield the eyes of the operator, and at the same time direct the light in exactly the right direction on the work. I have particularly noted the effect of this lighting installation on the operator and must say it is most pleasing. Operators like to work on well-lighted machines and particularly appreciate this form of reflector. The eyes are protected from the light and the operator works along steadily all day, in what was previously a dingy corner, with perfect ease.

Fig. 2 shows the lighting of a printing shop. The girl on the right is operating a wire-stapling machine, and the angle shade before mentioned is particularly well adapted to the work. The girl on the left is operating a small paper piercing machine, and the burners in this case are equipped with metal cone reflectors. The illumination on the work in all of these cases is extremely high and care has been taken to shield the eyes of the operator from the light; and this is the secret of good shop lighting.

It might incidentally be noted that in this shop electricity is used as motive power, the motor being shown in the upper part of the picture, while gas is used exclusively for lighting, not only because it proved so much cheaper, but because of the superiority of the light. In the background will be noticed a couple of gas arc lamps. These are used for the general illumination of the room, where they are quite necessary. These lamps alone, however, have never proven satisfactory for lighting machinery, unless placed very close together to avoid the intense shadows produced by parts of the machines themselves. In such cases the gas bills have proven abnormally high. I know of several factories, previously lighted by gas arc lamps, that have cut down the number of such lamps and placed individual inverted burners over the machines.

Fig. 3 shows an operating room in a garment factory. The sewing machines are arranged on either side of a long work table, and the inverted burners are suspended in such a manner that each machine shall be lighted by at least two burners. The burners are equipped with cone reflecting shades so as to reflect the light on the work, and are elevated to such a point that the mantle cannot be seen by the

FIGURE I.

operator. The general light in the room is obtained by inverted burners fitted with flat reflecting shades. This equipment gives a very wide distribution below the horizontal, and is very well suited to this kind of work, where, in addition to the sewing machines, there are several very large work tables which have to be well lighted.

Fig. 4 shows a large cylinder printing press. Four inverted burners are used to light this, two on the right lighting the feedboard end, and the two on the left the delivery end. A very good illumination is necessary here, particularly when 3-color work is being run off. The inspection, while necessarily rapid, must be very close and every detail must come up clearly. The inspector must be able at a glance to tell whether he has the proper register. In talking with the men operating this machine they stated they had never before worked on a machine so well lighted. Now, on every job it becomes, of course, necessary to arrange the form. When this is done the feedboard is turned back, as shown, allowing the light to pass down to the form, and Fig. 5 shows the operator in the act of inspecting and arranging the form. It will be noted that the two burners on the right end of the machine are placed so that the form is well lighted.

Fig. 6 shows a row of narrow fabric looms in the plant of a company making millinery supplies. It will be noted that there is good illumination not only on the upper-central portion of the machines, but the light is thrown well down through the machines to the floor. [For Figs 2 to 6, see following pages.]

Mr. J. L. Bailey has been elected Treasurer of the Baltimore (Md.) Consolidated Gas, Electric Light and Power Company, vice the late Mr. Joseph W. Clarke. Mr. Bailey was the Company's Auditor. Mr. R. L. Bonsall has been been appointed Assistant Treasurer to the Company.

Effects of Light Upon the Eye.[1]

[A paper read by Dr. H. H. Seabrook, before the New York Section, Illuminating Engineering Society.]

It is manifestly impossible to know what effect light may have upon the eye without knowing something about the structure of the eye. In the schematic anterior-posterior section of the eye presented in Fig. 1, and the description

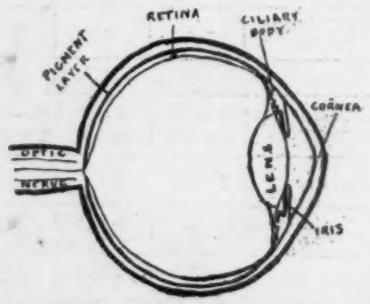


Fig. 1.—Schematic Anterior-Posterior Section of the Eye.

thereof, only enough of the anatomy is given for an understanding of the references which follow later.

The transparent anterior part of the eye, the corners and the lens behind it, are the main factors in focussing rays of light upon the membrane lining the eyeball, the retina, forming within it an inverted image of any object toward which the eye may be directed. The sensation from this image is carried by fibers in the retina and optic nerve to the brain, and there interpreted according to education and experience. The posterior layer of the retina consists of cells filled with pigment which absorbs light. The whole process which occurs in the retina under the action of light is one of disassimilation, and repair takes place in the dark. The pigment layer extends forward over the ciliary processes and forms the posterior layer of the iris. The ciliary processes are folds rich in blood vessels and nerves. They furnish a low grade nutrition for the lens, and their veins must remove waste tissue, including pigment disassociated from the cells by the action of light; when much work of this sort is required the process may be painful. The ciliary body consists of the ciliary processes and the ciliary muscle, which latter contracts and allows the lens to become more convex so that near objects may be seen. This process, called accommodation for near objects, may result in pain about the ciliary region from strain of the ciliary muscle when near use of the eyes is too long continued. As an optical instrument the eye is defective. It has chromatic aberration, spherical aberration and other forms of irregular astigmatism, usually measurable, and regular astigmatism and other refractive errors peculiar to the individual. These errors when not corrected cause irradiation of light with the eyeball, with consequent irritation, because rays are not properly focussed. When eyes are corrected with glasses, excessive and irregular action of the ciliary muscle is often removed, but since irradiation of light is bettered and glass filters or stops the chemical rays, the ones injurious to the eyes, it is difficult to separate eye strain due to light from that due to accommodation.

That the delicate retina is not often badly injured or actually destroyed by sunlight must have caused comment among early observers in physiological optics, as the difference between heat, luminosity and chemical action from light was long ago recognized. The discovery of the composition of white light, the development of photography, the oft-mentioned similarity of the eye and the camera, and the recognition of the ultra-violet rays, evidently set men thinking anew about the natural defences of the eye against such a powerful destructive agent as light. There are three methods of protection plainly in evidence. These are partial or complete closure of the lids; the action of that circular curtain, the iris, especially when its central aperture, the pupil, is narrowed by exposure to light, and lastly, the

1. Reprinted from the "Transactions" of the Society.

FIGURE 2.

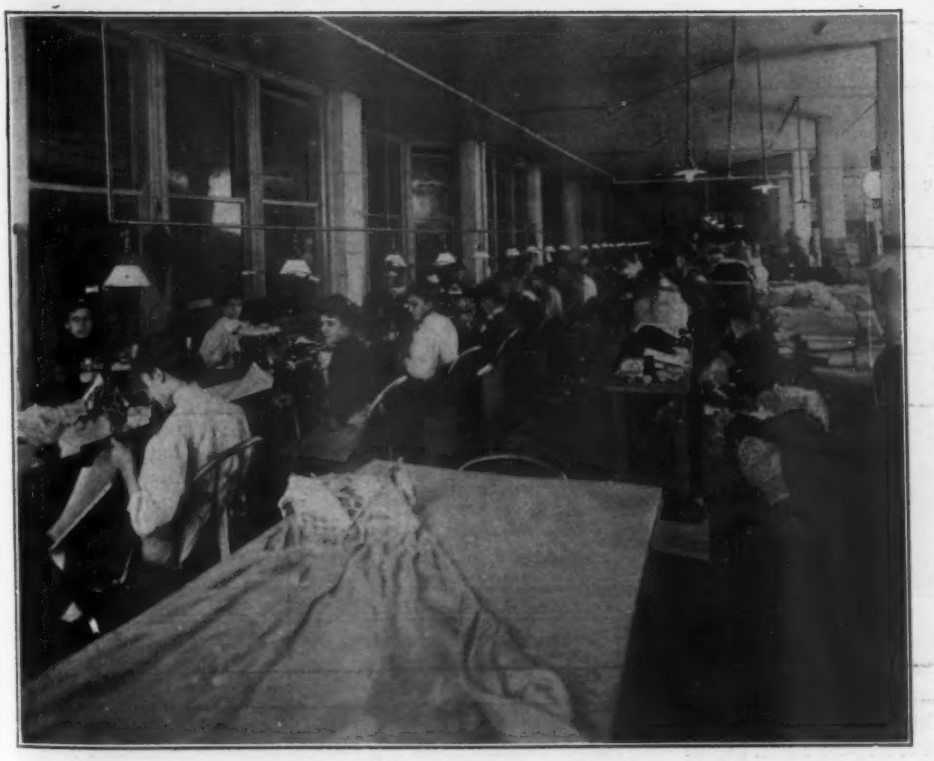


FIGURE 3.

frequent movement of the eyeball so that any one portion of the retina may not be fatigued from too long exposure to white or colored light. Anatomists exaggerated the power of endurance of the pigment layer in the absorption of light, yet even then it was hard to see how the retina escaped as well as it did.

In 1845 Brücke tried the effects of ultra-violet rays upon tincture of guiac, directly, and after passing through the media of the eye of the ox, and found that these rays were largely absorbed by the lens and to a less degree by the other media and the cornea. Donders, 8 years later, concluded that the lens had no power of absorption of ultra-violet rays, since the fluorescence of quinine solution from these rays was apparently no less when sunlight was filtered through the lens of the pig, sheep or ox than through glass. Ultra-violet rays do not pass through glass without loss, and de Chardonnet showed later that different results occurred according to species. The human lens absorbs spectral light at the *H* line and absorption is complete at *L* or *M*. Helmholtz, influenced by Donders, concluded that the absorption power of the animal lens was small, but when experiments were made upon animals in which the lens of one eye had been removed and that of the other left, and the electric light was brought into use, as well as sunlight, and the results upon the different eyes, as observed by many careful men, tabulated, no doubt was left as to the results. In 1904 Birsch-Hirschfeld took up the matter after very nearly 20 years' time had elapsed since other investigations, but with most painstaking work was able to do little more than confirm principles already established. Certain things seem worthy of mention, although only a brief general review of the results is possible here. The damage to the external parts of the eye, including the lens, is directly proportionate to the strength of current and length of exposure. With a current of 3 to 4½ amperes from a Finsen lamp, with the iron cooled by water so that the lamp was not hot to the skin, chemical changes were produced in eyes in 4 or 5 minutes. These were a certain puffiness and change of color of the anterior coats except the cornea, with slight cloudiness of the cornea and shedding of cells covering its posterior surface, and congestion and discoloration of the iris. The layer of cells lining the anterior capsule of the lens, from which its fibers are formed, also showed injury. Inflammation followed 12 to 24 hours after exposure and subsided in 4 or 5 days, although eyes were not normal for 4 or 5 weeks, even when they escaped permanent damage. The protection from the lens varied greatly in different individuals. Exposure to ultra-violet rays caused damage to the gangloin cells of the retina in ½ to 1 hour in eyes without the lens and with a longer exposure in eyes retaining the lens. With repeated exposures, even if the chemical light was not very intense, cataract would be formed. This opacity of the lens would then be permanent. Spectral rays of sufficient intensity cause damage, but the blue, and still more the violet, rays are the really harmful ones.

Disintegration and disassociation of the cells in the pigment layer, occurring from exposure to light, are at a minimum in yellow light. A natural suspicion that heat rays cause damage to the eyes has never been confirmed; discomfort may perhaps be caused by them, but no tissue changes.

Injuries to the eye occur to the human race from both natural and artificial light. The best

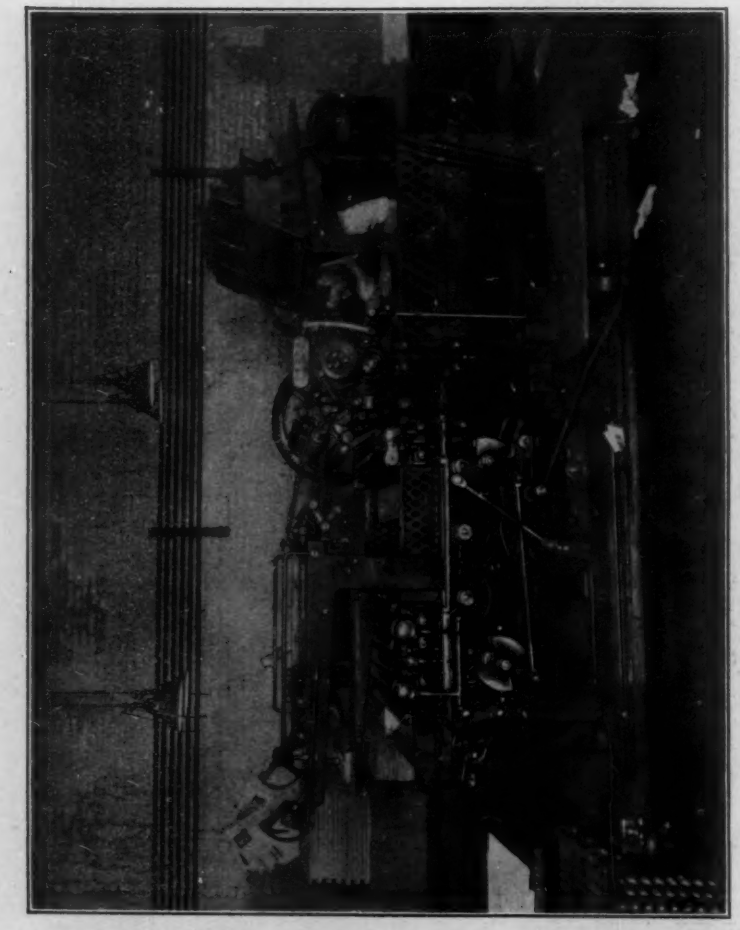


FIGURE 5.

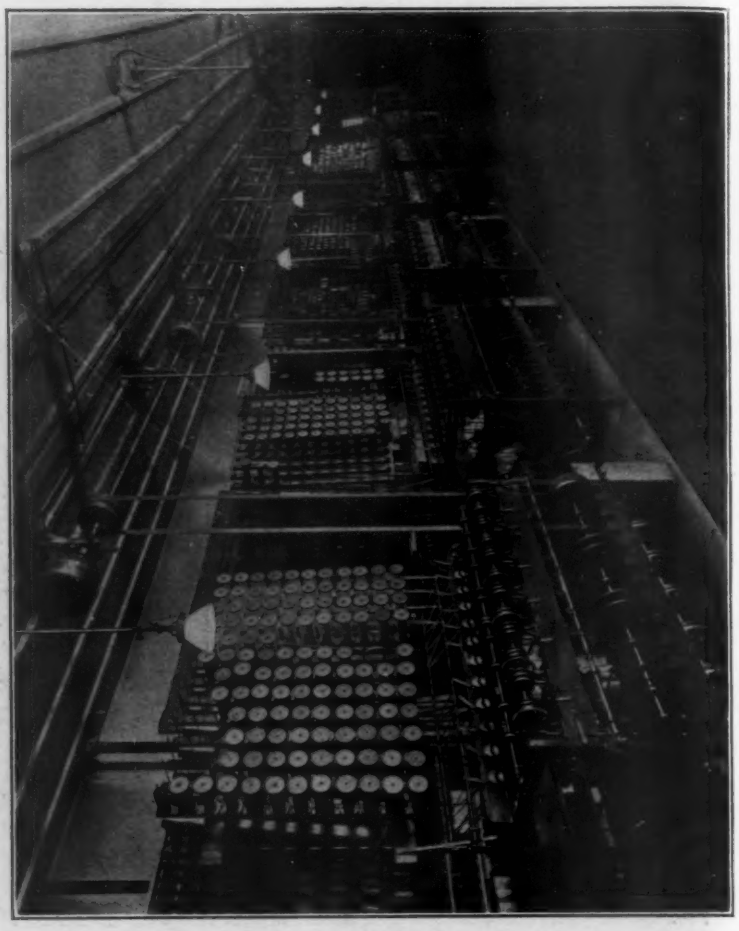


FIGURE 6.

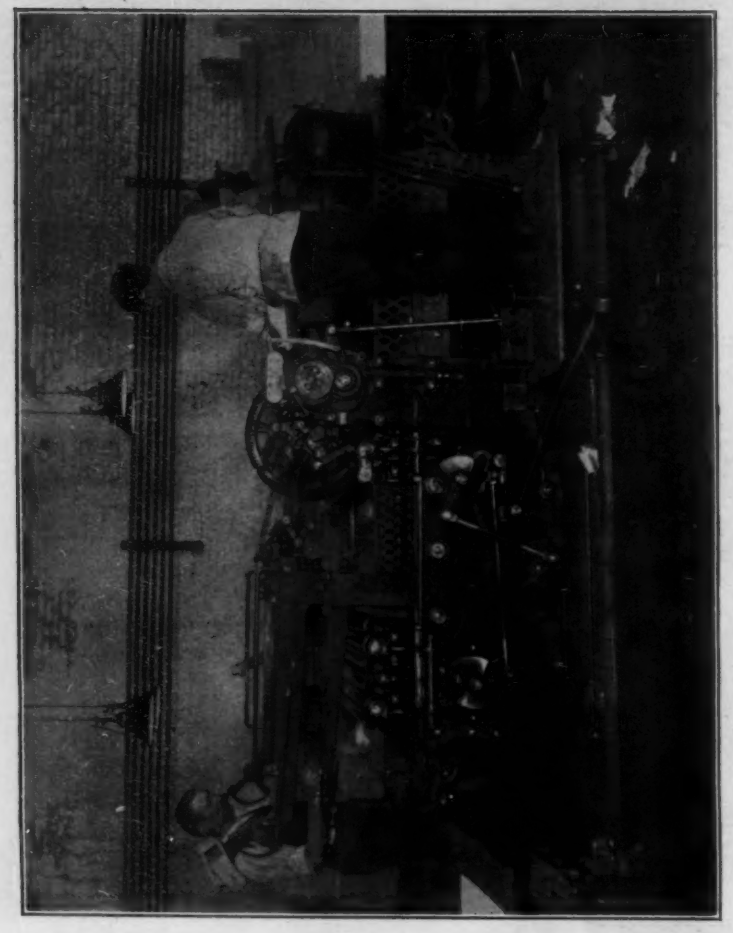


FIGURE 4.

known of these is snow-blindness, due to exposure to reflected light from snow in a clear and rarefied atmosphere. Chemical rays are absorbed by atmospheric dust, and the "yellow sunlight" is safer for eyes than the clear, white light of the sun. To the objective signs given previously, as seen in rabbits' eyes exposed to the Finsen light, are added gritty sensations, from the inflammation of the lids, and impaired vision, or complete blindness. The same results follow exposure to strong electric light, and about the year 1890 medical journals had many reports of such cases due to the arc light. Such results still obtain, but as they occur mostly among workmen who know that the damage to the eye usually causes little if any permanent impairment of sight, medical advice is not frequently sought. Those exposed have learned how to protect their eyes better than formerly, and no doubt such cases occur proportionately less often than formerly. Exposure to direct sunlight is so evidently injurious that it is avoided, although occasionally bad results occur from recklessness in viewing an eclipse. A permanent defect in the center of the retina, just where the sun's image was focussed, is often the result. In persons struck by lightning or where exposed to very bright electric flashes, eye troubles similar to those above noticed may occur, and an opacity of the lens sometimes results.

The severe injuries to the eyes from light already mentioned have but little practical bearing upon the work of illuminating engineers. No one expects the demand for brilliant light upon streets or in public buildings to be ignored, and the flaming arc lamps, Moore tubes and Welsbach streets burners, each in its particular sphere, to be replaced by kerosene lamps. There are many other things to be considered in lighting large areas besides the eyes, which may be protected from too powerful light fairly well by frequent changes in their position and consequent rest to the exposed portions of the retina.

Illumination for near work, however, is in a most unsatisfactory state. Our country leads the world, apparently, in the brilliancy of its artificial illumination, and certainly leads the world in ocular exhaustion, discomfort and congestion.

When gas came into general use these troubles began to increase, and a further increase was in evidence as the incandescent electric lamp came more and more into fashion. Both here and abroad, oculists agree that the kerosene burner is the least harmful artificial illuminant. They might leave the word artificial out with propriety, for no damage has been traced to kerosene light. The most satisfactory light is, no doubt, daylight (not sunlight) a few feet within a closed window on a bright day. In this light, finer lights and shadows and delicate colors may best be distinguished by healthy eyes. A greater distance from the source of light diminishes vision, and even taking away the protection of the window glass, causes

more dazzling and decreased retinal endurance. The adaptability of the eye is small for increased illumination, and the limits of increase of vision with stronger light is within the medium limit of illumination. The light should come from the rear and left and fall upon the object. If the latter has a glazed surface which reflects white light, fatigue is more rapid than with a dull surface, for below the surface of objects chemical rays are absorbed and color and visibility is due to that portion of the white light which is not absorbed but returned to the eye from below the surface.

Analyses of light, as published, are difficult to comprehend by one who is ignorant upon the subject. Daylight, or sunlight, is a variable standard to take without further definition or explanation of the conditions. Meyer's analysis, as given by Cohen, has violet in the electric (arc) light as .3 to daylight 1, and as given by Staerkle, 1. An analysis published by the Acetylene Company gives for the violet in the arc light 1 to 1 for sunlight. Staerkle gives, for gas, violet .1; Cohen, .3; the Acetylene Company, 1.15. Let us suppose that one table, giving the kerosene burner as very weak in violet rays, is correct, and another with ostensibly the same standard, omitting kerosene, is correct in giving the electric incandescent lamp what is meant to be the discredit of the weakness in violet rays as compared to the other illuminants; we must then look for contributory causes which have caused the incandescent lamp to give rise to more chronic eye degeneration and disturbance than any other light used for near work. Acetylene may be thrown out on account of lack of opportunity for much damage. The image of the brilliant filament of the incandescent lamp, with its concentration of light, must harm the retina more than the more diffuse images of flames; the benefit from ground glass globes for this light, when the eyes are exposed to its direct rays, must be partly due to diffusion of the light. Without ground glass, this light is more steadily brilliant than kerosene, gas, or the gas mantle burner, and there is less chance for retinal recuperation. Ground glass reduces all the rays of the light about 25 per cent. In searching for other causes of trouble, we note that the movable kerosene lamp may be, and is usually placed in a good position to illuminate the object, while the incandescent electric lamp is usually not well placed, often in offices being rigidly fixed so that either the eyes must be subject to direct light, or the head must be bent forward for work, congesting the eyes. No amount of green on a tin shade will correct this improper permanent position of the lamps. Again, we notice how very thin the glass bulb of the incandescent is compared with the lamp chimney, and since glass of 5 millimeters thickness absorbs 29 per cent. of the chemical rays of sunlight at an angle of 60° (Hankel), we conclude we have another element of trouble, as chemical rays are absorbed by glass in proportion to its thickness.

The Welsbach mantle changes the ordinary gas flame, with its marked excess of red, to a cold light, deficient in that color. It is less irritating to some eyes than other lights, but more irritating to others.

Many substances absorb chemical rays and allow luminous rays to pass. For practical purposes there seems no need to consider any of them except glass as a protection for the eyes from the intrinsic brightness of too intense light. Neither does there seem any question that yellow is the color to choose to conserve or improve vision and protect the eyes from the chemical action of light. Globes may be used of pink, orange, red, or green, as desired, when the light may be diminished in luminous qualities. It is best to choose for protective purposes that shade of yellow which appears in the best ray filters or is shown in the glass used for modifying the light of developing rooms for photographic plates. This amber yellow may be darkened by a brown admixture for weak or diseased eyes, or unusual light exposure. It is difficult to manufacture without imperfections, and the supply slowly follows the demand.

That the study of illumination for practical purposes is difficult no one will deny. The difficulty of conveying knowledge about light, even if one possesses it, must be great, for there is no definite language, as of medicine, for instance. Newton first separated light into primary colors, and he also advocated the corpuscular theory of Descartes; and after more than two centuries we use Newton's language and speak of chemical rays in order to be understandable, and compound such sentences as "Since the wave lengths at the violet end of the spectrum are but half the length of those at the red, twice as many chemical rays as heat rays, from white light, enter the eye during the same period of time." When we speak of light in general, we usually mean light with infra-red, spectral and ultra-violet effects. Light rays may mean the visible spectrum, or the luminous yellow. The expression primary colors has just been used. It meant then the 7 colors to be distinguished in the spectrum by many eyes, or the 6 that can be recognized by the others. It is frequently applied to the fundamental pigment colors, red, yellow and blue, from which all other pigment colors may be produced by mixing; or the fundamental spectral colors, red, green and violet.

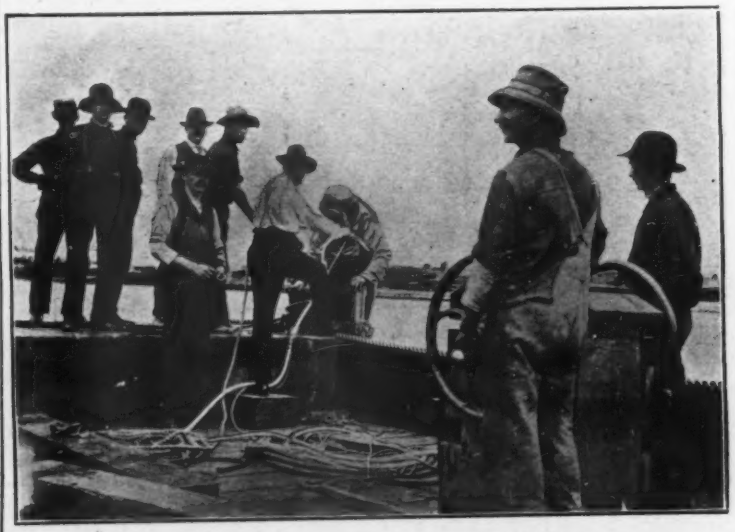
Illuminating engineers are not entirely satisfied with standards of measurement of light; they would be still more confused if the visual standards which oculists have used for many years should be presented to them. Vision for distance only has been considered, and the apparent contradictions in facts, the long descriptions of investigations by Germans, often followed by conclusions entirely at variance with the premises, the conclusions of others, especially Americans, upon no premises at all, make "laws," as they were formerly called in these studies, rather difficult to formulate. In the present instance, you are asked to believe what many of you already know, that the desire for intensity of light has been already overdone as regards the good of the eyes. The small but increasing portion of the consumers who wish a light that is soft to the eyes ought to be encouraged.

As regards deductions to be drawn from this paper they are not difficult. Lights weak in chemical rays are better suited to the eyes than others. Present lights may be improved by attention to position, including the distance of the source of light from the eyes, as measured by the course of the rays, and protection of eyes by glass properly colored.

Take the spectrum of daylight through a window, and that of kerosene, argand, Welsbach and incandescent electric lamps, from just where you would sit to use them for near work, see what shade of amber yellow glass it takes to cut off the blue and violet rays, and you will find under those conditions the kerosene burner at one end of the list and the incandescent filament at the other.

A Good Example of Pipe Line Diving Work.

Almost everyone along the Great Lakes, either residents or those who have to do with their waters in one way or another, surely must have heard of E. G. Williams, whose feats of work done under water are likely not equaled by those of any other land lubber who makes his livelihood by recovering that which the bottoms of the unsalted seas would destroy. Late last July, at a point about ½ mile below the international bridge crossing the Niagara river, the 8-inch pipe line of the Buffalo Natural Gas and Fuel Company makes its crossing, a break happened that was quite likely caused by the keel of some deep



draft steamer. The line was separated completely about 700 feet from the American shore, in a depth of water not less than 15 feet, and with a current equaling 10 to 12 miles an hour. The situation was an odd one, but Williams, with his crew, were on the scene speedily and got after the break right away. The illustration shows him in the act of "going over the side." Locating the break, he got the two ends together, sealing them up by means of a split sleeve weighing 1,200 pounds. This work was all done alone, unless one cares to mention the fact that, to go on with it, Williams had to have the aid of an 800-pound weight.

Pipe-Screwing Machine.

The machine illustrated herewith, which has just been put on the market by Messrs. Charles Winn & Co., of Birmingham, England, and which will accurately and speedily manipulate pipe up to 6¼ inches diameter, has received the unqualified indorsement of many prominent European engineers.

It is of heavy construction and is well designed to withstand the hard and rough usage tools of this class are often subjected to; while certain features enable it to handle work more quickly than is possible with the ordinary machines. The machine is provided with a 4-step driving pulley and double train of gears. The spindle is, of course, hollow, and has a quick-grip chuck at the front end for holding the tube, and a 3-jaw self-centering chuck at the back end for steadying. By means of the special quick-grip chuck the tube can be instantly gripped or released while the machine is in motion by a movement of the capstan lever, shown in Fig. 1, under the chuck. For large adjustment in the size of tubes the chuck is quickly altered by revolving its outer ring to an amount shown by the index on its periphery. The dies consist of a set of 5 chasers, opened and closed by the hand lever shown, and are set to size to an indicator scale on the die head. An adjustable stop is now fitted to these machines, to insure that the dies close to the same amount each time.

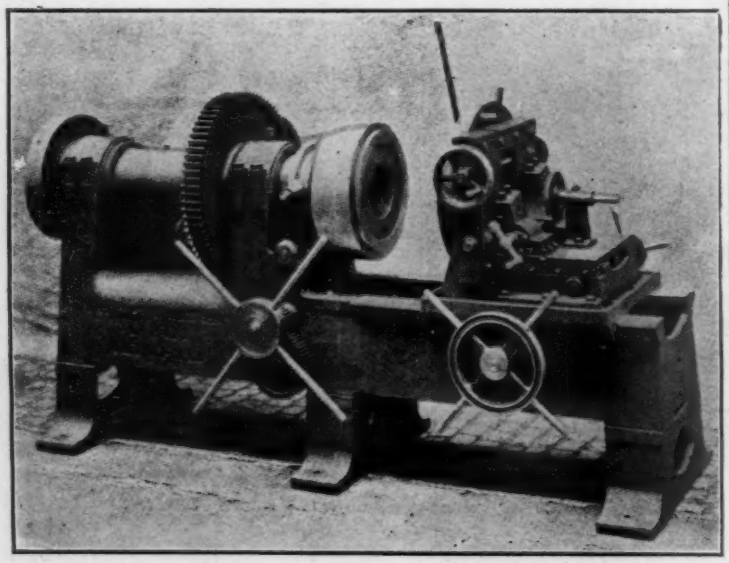
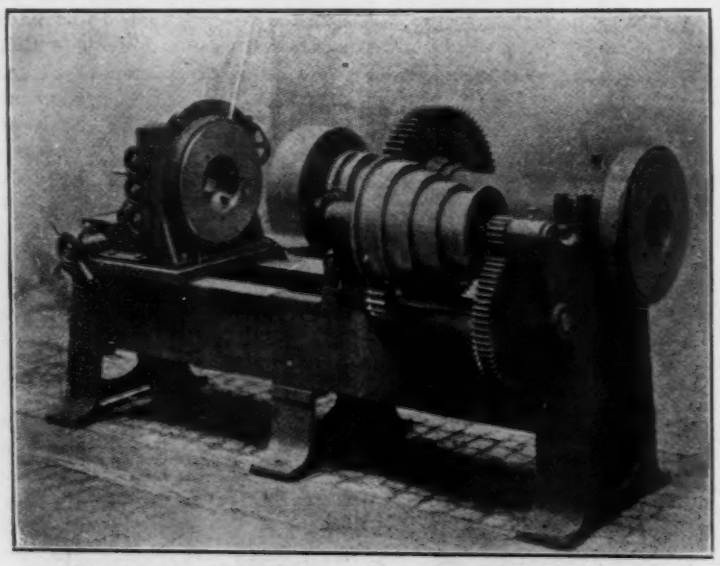


Fig 1.



A parting-off slide is fitted at the back of the die head, and is to be seen in Fig. 1. The adjustable stop, also visible in this figure, is only used when the machine is making nipples. In making nipples the tube is pushed up against this stop and cut off. Both cutting off and screwing proceed simultaneously, so that while the parting tool is cutting off a nipple of standard length the dies are threading the following length of pipe, resulting in a considerable saving of time. The bed is of trough section, forming a reservoir for the oil and swarf used. The weight of the machine is 2 tons 7 cwt.

Extracting Cyanogen from Gas.

English Letters Patent (No. 2,090) were issued January 28th, 1907, to Mr. R. Lessing, London, England. The wet extraction of cyanogen from coal gas or like gases in the form of iron cyanogen compounds has, the patentee states in his specification, hitherto been effected by various processes, of which the washing and scrubbing of the gas with ferrous salts were the main features. The iron was applied either in the form of aqueous solutions of soluble iron salts—such as the sulphate or chloride, or else in the form of suspensions of iron oxides or insoluble iron salts, such as sulphides or carbonates in solutions of hydrates or carbonates of the alkalies or in milk of lime. It was also proposed by Dr. Knublauch (in his English patent No. 15,164 of 1887) to replace (in suspensions of iron oxides, carbonates or sulphides) the alkali required by ammonia; the iron compound being either brought into the liquid or formed therein by chemical decomposition or synthesis. However, in the process referred to no objection was made to the presence of acid radicles which form "fixed" ammonium salts—that is to say, compounds from which the ammonia cannot be expelled by boiling without the addition of alkalies or alkaline earths. The formation of these "fixed" ammonium salts causes the neutralization of part of the free ammonia present; and the present patentee says he has discovered that, by thus reducing the alkalinity of the gases or the reacting mixture, the ready extraction of cyanogen is impaired, and that the presence of the "fixed" ammonium salts is prejudicial to a convenient working up of the resulting products.

His invention therefore relates to an improved method of carrying out the prior process referred to, of extracting cyanogen from gases, by which the presence and formation of neutral ammonium salts is avoided; and it consists in washing or scrubbing the gas previous to the extraction of ammonia with suspensions of ferrous oxide, hydroxide, or such iron salts of the protoxide type the acid radicles of which do not form "fixed" ammonium salts on entering into combination with ammonia. These iron compounds—such as ferrous hydrate, carbonate and sulphide—are suspended in water, or in ammoniacal liquor free from fixed salts, and they may be used each by itself or in mixture with one or more of the others.

Dr. Lessing has found that such a washing or scrubbing agent avoids the "fixation" to other than to ferrocyanide radicles of ammonia and its transformation into indifferent ammonium salts, which unnecessarily load the reacting mixture and render the subsequent working-up of the products more complicated. Further, using the ammonia present in the gas and dissolved in the suspension liquor as a base for the formation of iron cyanogen compounds, the present process avoids the employment of any alkali in the extraction.

The invention may be carried into effect in various ways, of which the following may serve as examples:

The washing or scrubbing liquid is prepared by precipitating from a solution of a ferrous salt—such as ferrous sulphate or chloride—the iron by means of ammonia or ammonium salts other than "fixed" salts or the corresponding compounds of the alkalies. For example, a ferrous sulphate solution may be treated with the vapors from an ammonia still or with a condensate thereof, or with crude coal gas containing ammonia from which cyanogen has been previously removed, or it may be precipitated with alkali carbonate or sulphide or caustic alkali, or ferrous salts, the radicles of which form soluble salts with the alkaline earths, may be treated with milk of lime or the like. For instance, the iron cyanogen sludge obtained by a previous working, as hereafter described, may be treated with milk of lime, yielding calcium ferrocyanide, and leaving a suitable ferrous material as residue.

In any case, the salt solution is separated from the ferrous hydrate, carbonate, or sulphide by decanting or filtering, and the precipitate is washed, if possible, in a filter press or a centrifugal extractor, or on a vacuum or other suitable filter. During these and the subsequent operations, the access of air or oxidation of the material generally should be avoided. The ferrous precipitate prepared by any of these methods (or a mixture of such precipitates) which will be in a more or less pasty form, is then suspended in water or ammoniacal liquor containing practically no "fixed" ammonium salts, or in the distillate from ammonia stills, whereby care should be taken to divide the precipitate finely and distribute it evenly throughout the fluid by stirring or agitating the mixture. The strength of the suspension will have to vary according to local conditions and the products desired. A mixture containing about 0.5 to 0.6 pound of iron per gallon of liquid has been found to give satisfactory results.

With this suspension the gas is washed or scrubbed after the ex-

tra tion of the tar or tarry matters, which should be as complete as possible and previous to the extraction of its contents of ammonia. Any efficient gas washing plant may be used. With the aid of the ammonia present, practically all the cyanogen contained in the gas is absorbed by the ferrous compounds—forming a more or less fluid sludge of black or bluish grey appearance, which is very suitable for the manufacture of ferrocyanides according to known methods.

Herr Otto Vogel on Mercury Vapor Lamps.

Herr Otto Vogel in a communication to the "Zeitschrift für Beleuchtungswesen" on the mercury vapor lamp, contributes some interesting matter regarding its merits and demerits. The lamp, it is said, is exceedingly simple, easy to attend to, steady and uniform; it consumes wonderfully little current, as it gives 2 to 5 Hefner candles per watt; it consumes no carbon; it is safe amid explosive mixtures of gas; it does not affect the air of the room; and it varies very little in its brightness when the current supplied to it suffers fluctuations.

It is a good deal used in works, particularly where a safe light is required; but for other lighting, at any rate in Europe, it has made but little way. Why is this? The reasons are twofold—first, the color of the light; second, the question as to lighting the lamp up.

As to the color of the light. Red rays are wanting in the light produced; and the consequence is that persons look ghastly and food looks repulsive. Add red rays, then; but how? To use, instead of pure mercury, an amalgam of mercury with lithium or strontium leads to nothing; the mercury alone seems to act. Use red glass for the tube or round the tube, or sink the tube in a solution of rhodamine, which fluoresces red, or surround it with silk dyed in rhodamine-stain varnish; all this, again, leads only to negative results. The problem is not yet solved.

As to lighting up the lamp. Nothing can be simpler than the small models; tilt the lamp and let it return—a spark is produced and the vacuum discharge has started. With bigger lamps, however, we get into great complexities. Mercury is an awkward thing to tilt about in glass vacuum tubes, for it may break these; and electrical contrivances for working the required movement land us far from the original simplicity of the small models.

But, further, the glass itself may give rise to trouble, and that in three ways. First, the hot mercury vapor acts chemically upon the glass, sooner or later. Second, the glass itself acts like the magnesia in a Nernst lamp—an insulator when cold, it is a semi-conductor when hot, and, after a while, current is wasted by running along the glass tube; and not only that, but the glass is electrolyzed and dimmed by this escape of current, and its life is shortened. Thirdly, there is a wealth of ultra-violet rays, which tend to etch the glass and make it fluoresce, to color it and make it less transparent, to produce cracks in it which become filled with some dark material, and to cause the evolution of loose molecules from the gas which depreciate the vacuum, all of which brings about deterioration in the efficiency of the lamp.

No wonder, then, the lamp lasts no longer than 3,000 to 5,000 hours, and may break down in 2,000, or even less.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, Jan. 10th, 1908.

A Modern Pharoah.—Lighting of Shops and Libraries.

The ancient Egyptian tyrant who demanded bricks and stopped the supply of straw, is quite out of the running as compared with the Urban Council of Fermoy, a little town in Ireland, who have called upon the Gas Company, under threat of legal proceedings, to remedy a nuisance caused by an escape of gas in the public road, and at the same time claim the full control of the roads and forbid them from opening the ground. This very Irish state of affairs appears to have originated in some dispute between the two authorities, and the object is to force the Company to accept terms. It is stated that the chief question is the price of gas in the district. Matters have progressed further than mere words, for when a gang of the Company's workmen were set to work, to uncover the defective pipe, a gang of the Council employees were in attendance, and endeavored to fill in the ground as fast as the Gas Company's men threw it out. But the gas men made headway, and the next move was to fetch the town fire hose. Some of the Councillors considered that the occasion was opportune for giving the road at the particular territory in dispute a thorough wash down. Of course the fact that the gas men would either have to decamp, or stand the chance of being drenched with water, was an incidental issue. But gas men are used to work in all weathers and under wide variations of temperature, and they pluckily refused to budge in spite of the extraordinarily heavy showers. But after a time they got tired of it, and made a show of resistance, during which the hose pipe was cut. The Council were ready with another line of pipe, and some of the menbers took a personal part in the proceedings. The gas men still kept to their work, although a crowd collected and things began to look ugly, until at last a truce was called, to admit of a conference between the Council and the Company. No satisfactory settlement, however, was arrived at as the result of the discussion, and the town men were instructed to oppose the opening of the roads. In order to reduce the loss of gas to the lowest possible point the Company are keeping down the supply pressure, with the result that on one evening the district was in semi-darkness.

In relating these events as recorded in the local and the technical press, there is, of course, no intention of expressing an opinion as to the rights of one party or the other, but the case presents several features of general interest to all who have occasion to lay pipes or conduits in public roads, especially as the law is by no means clear on the points involved. It is generally supposed that permitting or allowing a pipe to be laid carries the right of access to it at reasonable times, subject, of course, to a minimum of public inconvenience and to proper replacement of the soil. Every reasonable means must be used to expedite the work, and to avoid interference with personal or vehicular traffic, and the soil must be left in at least as good a condition as before the disturbance. Whatever the legal aspect may be, this is the commonsense view. There are not only the rights of the owners, but the safety and convenience of the public to be considered, and it is quite as desirable, in the interests of one as of the other, that the lines shall be kept in sound condition. It is to be hoped that matters will not be complicated at Fermoy by explosion or poisoning as the result of the escaping gas. But if such a misfortune did occur, it is an interesting question as to who would be liable. The attempt of the gas company to repair the defect would be advanced as evidence that they had taken every reasonable means in their power. And it would be a very debatable point as to who was liable for the damages—the party who endeavored to effect the necessary repairs, or the party that prevented the same from being executed. I do not know whether the gas company in question is a statutory company, but the powers and obligations usually granted by Parliament certainly assume full right of access. It is absurd to hold a company responsible for not exercising due diligence in respect to the prevention of leakage, if their powers in respect to the necessary procedure are at the mercy of the whims of a second party. Apart from the rights of the public, no trading company would entrrtain the question of putting down pipes for the conveyance of their commodity and allowing the same to pass out of their control. A main pipe, as its name implies, is intended to carry branches for the supply of individual consumers, and at any time it may be necessary to connect new or to remove old services. At intervals, varying according to the circumstances, the conduit must be repaired or entirely replaced. It is always liable to displacement by accident or movements of the soil in mining districts. If it can be upheld that a gas company, having been allowed to lay a pipe in a public or private road, can be prevented from exercising reasonable access, the consequences will be serious and far reaching.

A report on the lighting of schools has recently been prepared by the medical officer to the Education Department of the London County Council, and it contains a great deal of matter that is not only interesting to all concerned in the supply of artificial light. but also to users of the same, and especially to those whose business or pleasure includes much desk work. It is obvious that where one is engaged for several hours daily at a table or desk, the question of the lighting must have a considerable effect not only as regards health and comfort, but also the quality and quantity of the work done. It has been observed, for example, that in occupations such as the sorting of letters or copying addresses, the quantity that can be turned out per hour is largely affected by the nature of the lighting arrangements. The number of persons employed in such work might be reckoned in

millions, and yet in the majority of cases the kind or quality of light provided is largely a matter of chance. If the operator considers that the light is "bad" he may enter a complaint, and get a larger source of light allowed, but the amount of light and the arrangements used for reflecting it, are dependent upon the fancy of the party who selects the apparatus to be fitted. The two points that are especially deserving of attention are the minimum desk illumination and the effect of the shade used in relation thereto. The report states that the result of a large number of experiments goes to show that the minimum desk illumination is 10 meter candles, which comes very close to the old established formula of one foot-candle which was accepted by gas engineers over half a century ago. It would be interesting to know what is the *maximum* illumination allowable, but on this point the report is silent. Plenty of light is now so generally recognized as a necessity, that the tendency to overlight is more marked than the other extreme, and with the general use of light curves extending up to 300, 400 or more candle power, there is more risk of suffering from too great an intensity of light than from too little. Before leaving this point, it may be observed that the report brings out the fact that a good air supply regulator, though theoretically unnecessary with a regular supply pressure, is practically a most important part of the burner and a device by which it is possible to considerably improve the light. Four different patterns of glass shades were examined, all of which were of the pattern now largely used in connection with incandescent burners, and generally known as "opal and flint," having clear glass at the lower part, and opal glass at the upper part, the object being to give a free deflection of light downwards, and to guard the eyesight from the direct rays of the light. It is worth noticing, in connection with this part of the subject, the brilliant coloring of shades is now quite out of date. At one time all sorts of curious sorts and sizes were on the market. Every conceivable geometrical pattern was brought into use, with or without scallops or frills. Scarcely a shape that is used for cups, basins or vases can be instanced that has not also been applied for a gas globe. All sorts of elaborate engine turned designs, or attempts at high art, such as landscape studies, animals, butterflies, or even portraits, have figured on the gas globe. But these are displaced in favor of plain designs in opal and flint. It may be safely prophesied that any light, of such a color as to require the assistance of tinted glass, is not likely to be a practical success, and one reason why incandescent gas light is so generally preferred is that it approximates closely in color to natural daylight. The question of color of light, however, is not referred to in the report. In dealing with the shape of the globe, it is pointed out that many of the common patterns are useless as regards the reflection of light downwards, because the angle subtended by the sides is too small. If the sides, whether straight or curved, approach so near the perpendicular as to subtend an angle of 40° to 50°, not much light will be reflected downwards. To obtain a satisfactory result in this respect, the angle must be about 90, which gives the sides an angle of 45°, approximating in shape towards the well-known conical billiard shade. From all this it is evident that when the late Mr. William Sugg introduced plain opal globes approaching a spherical shape, some 50 years ago, he was not far wrong.

There is a very general idea extant to the effect that electricity is the proper agent for lighting public and other large libraries. The heat and products of combustion from gas are supposed to have a prejudicial effect on the binding of the books, although it has been shown over and over again that this is more a question of proper ventilation and regular temperature than of the kind of illuminant used. The incandescent gas light, by largely reducing the consumption per unit of light and by securing complete combustion, largely reduces the risks that may arise, and many of the public libraries are now adopting it.

In a report recently issued by a Committee of the Camberwell Central Library it is stated that the question of the lighting has been carefully considered with a view of relieving the heavy cost of electricity. It was calculated that, by substituting incandescent gas, 50 per cent. more light could be had at one-sixth the cost. The reading room was lighted by this means, and it was found that after meeting the expenses of alteration there was a saving of £32, apart from the increased light. These results show that the question of cost in connection with large buildings is an important matter. Particularly in the case of committees responsible for dealing with public funds, or for the administration of charities, it is necessary to watch closely the various items of expenditure, and to see that economy shall be applied, whenever there is a chance of doing so without sacrifice of efficiency.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE latest "Bulletin" (Form 245) issued by The Gas Machinery Company, of Cleveland, O., has to do with water gas tar extractors of the P. & A. type, especially the one patented by the Company about 2 years ago. The "Bulletin" is so complete that anyone who reads it, even if half carefully, and fails to grasp all about the object of and results achieved by this useful instrument, should seek another occupation than that of engineer.

AT the annual meeting of the Dayton (O.) Gas and Coke Company Mr. Arthur Dickey was elected to the Directorate to the vacancy occasioned by the death of Mr. William K. Callahan. The other officers elected were: Directors, John A. McMahon, D. B. Corwin, H. C. Graves, A. B. Oglesby and John K. McIntire; President, R. R. Dickey, Jr.; Vice-President, O. I. Gunckel; Secretary, W. B. Gebhart.

THE proprietors of the Commercial Gas Light Company, of Oxford, N. Y., have served notice on their consumers that, on and after February 1st, the manufacture and distribution of gas will be discontinued, "on account of the present high price of gasoline."

MR. F. H. ENSIGN, Manager of the Pacific Gas and Electric Company's branch at Phœnix, Ariz., reports plenty of business, despite the hard times. The people of that section are quite enthusiastic over the advantages of gas for use in kitchen practice.

MR. C. W. BUTTERWORTH is rapidly getting the details of his new management—that of the Milton (Pa.) Gas Company—in smooth working order.

AT the annual meeting of the shareholders in the Willimantic (Conn.) Gas and Electric Light Company the following Directors were elected: George A. Lewis, D. F. Tilley, C. H. Evans, J. F. Church and C. W. Noyes.

THE Massachusetts Board of Gas and Electric Light Commissioners has filed its report concerning a special investigation made last summer and fall, at the direction of the General Court, as to "The purchase, sale and consolidation of gas and electric light companies, and to report as to the advisability or permissibility of the same." The Board's conclusions can be thus summarized: There is an undoubted opportunity for advantage, both in economy of investment and operation and in efficiency in favor of a large gas or electric light plant to serve a given territory over several small plants serving different sections of the same territory. The facts suggest not only the probability of further consolidations of lighting companies, but also the desirability of some such consolidations as in the public interest. It is important, however, in the opinion of the Board that the general policy of the legislature in regard to them shall be clearly defined. That if the legal theory under which the Edison Company has acquired other companies is correct, there seems to be no substantial reason why an electric company may not on the same theory purchase the property of a gas company. Furthermore, if the prohibition of the act of 1896 applies to the transfer of the franchise of a gas company and not to its property, the same legal theory might enable one gas company to buy the property of another and thus virtually to consolidate. In either case no public official or board passes upon the advisability in the public interest of such purchases and sales as a condition precedent to their validity. The Board is of the opinion that, unless the authority to pass upon the advisability of such consolidations is to be retained by the legislature, it should be delegated to the Board, so that it is consistent with the public interest. The Board is also of the opinion that this question is of so much importance to the stockholders of the respective corporations involved that such purchase and sale or consolidation shall not be authorized by the vote of a majority only, as it may be under the present practice, but upon the vote of two-thirds in interest of the stockholders of each corporation interested. The Board submits with its report a draft of a bill which it recommends for the consolidation by purchase of gas and electric light companies whose mains and lines are in the same contiguous municipalities, the purchasing or consolidated companies to have the same rights and privileges of the company selling so far as the same are applicable. No electric light company shall purchase the franchise or property of, or consolidate with, a gas company; and no gas company shall purchase the franchise or property of, or consolidate with, an electric light company; provided, that a gas company authorized to engage in the business of generating and furnish-

ing electricity for light and power under the provisions of Section 14 of Chapter 121 of the revised laws may, with the approval of the Board, exercise the authority conferred in Section 22 of that Chapter."

THE Commissioners of the District of Columbia, to whom was referred the Madden bill, under consideration in the last House of Representatives, ordering a reduction in the selling rate for gas by the Washington Gas Light Company, have returned the following report thereon: "That they are in favor of a reduction in the price of gas to whatever figure will yield a reasonable profit to the Gas Light Companies, as they have heretofore recommended to Congress. But, as they have also stated to Congress, they have not the authority or the means at present to determine what that price should be. They have recommended in their annual report that they shall be given the necessary authority and means to properly supervise the operations of all the public utility corporations in the District of Columbia, including the Gas Light Companies. If Congress will give them the additional authority and means needed, they will be able, with the advice of disinterested experts employed by them for the purpose of investigation, to arrive at the amount of reduction that ought to be made in the price of gas."

"C. M. O.," writing from Decatur, Ills., under date of the 16th inst., forwards the following interesting budget: "On January 11th the traveling salesmen of the H. Mueller Manufacturing Company concluded their annual School of Instructions, which lasted 2 weeks, the schoolroom being in the Company's home office in Decatur, Ills. Among other things to engage the scholar's minds was the Company's handsome, complete Catalogue, Series D, of gas, water and plumbing goods now in process of circulating through the trade. The work on this very complete book, and much thought, study and planning were involved in its preparation, was finished towards the close of December, and its delivery to the salesmen, who had been anxiously awaiting its appearance, was greeted with cheers. During the sessions of the School of Instruction, the catalogue was carefully and critically reviewed, with the purpose of enabling the road men to readily grasp its telling points. These instruction sessions have been productive of much good to the salesmen in the past, but there can be no doubt about it, that the current one was the record maker, for there was not a dull moment in the entire proceedings. 'School' was held daily in two sessions; from 9 A.M. to 12 M., and from 1:30 P.M. to 5:30 P.M. The President of the Company was the presiding professor, and his aides were the other members of it, not, of course, forgetting Mr. Fred. Mueller, who, of course, is known to almost every gas man in the country. The students found relaxation in their annual session of 'The '49 Club,' which conclave was held the evening of January 7th. There were three candidates for initiation: Messrs. W. F. Hennesy—to whom is intrusted the job of holding down the boroughs of Manhattan and the Bronx; R. M. Hastings and E. D. Fletcher. Type and printer's ink are inadquate to properly or even feebly afford an intelligent or understandable recounting of that which actually happened to them during a trying period of 1½ hours. However, that they really felt they were true '49ers would seem to be shown by their slow rendering, in solo and trio, of the touching ballad 'I got mine.' Much of their troubles was due to the guiding sense of the President of the '49ers', Mr. M. T. Whitney. Following the initiation and its accompaniments the members and their guests visited the Strouse Cafe, where a banquet that was enjoyable was enjoyed. Mr. Adolph Mueller made as good a toastmaster as Mr. Whitney did a taskmaster, and I need hardly say that a good bit of speechmaking was put through. The Club elected Mr. F. J. Murphy as President, and he certainly is popular with his fellows."

THE legion of friends who acknowledge the leadership of Col. Frank S. Richardson, President of the North Adams (Mass.) Gas Light Company, will be glad to know that he is more buoyant than ever. He has just been elected an active member of the Aero Club, of New England.

MR. EVERETT E. KING has resigned the position of Treasurer to the North Attleboro (Mass.) Gas Company.

THE local papers have given notice of the strangely sudden disappearance of Mr. Harris C. Kramer, Manager of the Tri-State Gas Company's offices in New Cumberland, O.

IF this is not the acme of assininity, to what further lengths may such quadruped go? This despatch was sent out by the "United Press" from Albany, N. Y., under date of the 14th inst.: "Persons using illuminating gas will pay for the pure article instead of for air, as claimed in many cases, if Assemblyman Hackett's bill, introduced to-day, becomes a law. It forbids corporations manufacturing gas from using engines or pumps for forcing air or other gases into the holders for the purpose of increasing the pressure of illuminating gas. A fine of $1,000 for each day a violation continues is provided. The Governor is to appoint inspectors, the salary to be fixed by him and the expense to be divided pro rata among the companies." Can anything exceed this for sheer ignorance of the subject? "Forcing air or other gases into the holder for the purpose of increasing the pressure of illuminating gas?" Well! Well!! Well!!!

AT the annual meeting of the Newport (R. I.) Gas Light Company the officers elected were: Directors, Melville Bull, Andrew K. Quinn, Henry Bull, Jr., Thomas A. Lawton and W. T. Bull; President, Melville Bull; Secretary, Thomas A. Lawton; Treasurer, A. K. Quinn.

AT the annual meeting of the Slatington (Pa.) Gas Company the officers elected were: President, Walter L. Jones; Vice-President, John Taylor; Treasurer, Joseph Richards; Secretary, H. E. Graffin.

THE annual meeting of the Springfield (Mo.) Gas and Electric Company resulted in the following choices: President, G. W. Little; Vice-President, E. B. Lewis; General Manager, W. A. Bixby; Secretary and Treasurer, N. J. Cunningham.

THE Des Moines (Ia.) Gas Company's payment to the city on account of the 2 per cent. tax on its gross receipts, for the half year ended December 31st, amounted to $4,386.84.

THE Indianapolis (Ind.) Gas Company gained 1,933 meters in the last half of 1907. The sendout for 1907 all but reached one thousand millions cubic feet.

DALLAS, TEX., is considering the advisability of going in for public lighting on a large scale by substituting mantle lamps for electric arc lights.

AT the annual meeting of the Springfield (O.) Gas Company the officers elected were: President, F. E. Randall; Vice-President, W. H. Brice; Secretary and Treasurer, E. W. Hanley.

MR. GEORGE H. CARPENTER, of Crookston, Minn., has applied to the authorities of Valley City, N. D., for the right to there construct and operate a gas plant.

MR. JOSEPH P. BUTLER has been appointed Assistant Gas Commissioner for Omaha, Neb., vice John Lynch, resigned.

AT the annual meeting of the New Orleans (La.) Gas Light Company the Directors elected were: E. C. Foster, Chas. Godchaud, Pearl Wight, M. Stern, A. Britton, George A. Hero and J. H. DeGrange.

MR. F. E. BOWMAN, formerly prominently identified with the Huntington (Ind.) Light and Fuel Company, has been appointed Manager of the Ada (Okla.) Electric and Gas Company.

AT the annual meeting of the Norfolk (Neb.) Gas and Fuel Company the following officers were elected: Directors, J. W. Ransom, H. J. Cole, H. T. Holden, C. J. Hibben and C. E. Doughty; President, J. W. Ransom; Secretary-Treasurer, H. J. Cole.

A VISITOR named A. J. Dietz, who is loud in his declaiming that he "represents Eastern capitalists," is busily engaged in securing, or attempting to secure, signatures to a petition declaring that the signers will agree to take gas from a company (to be formed, mind you), that he will organize when 1,200 signers have appended their names. The scene of his operations is Bellingham Bay City, Wash. Of course, "his company" proposes to sell gas at a rate very much lower than that charged by the existing Company, with all the other verbiage doses usually administered by missionaries of the Dietz type.

THE royalties paid by the Omaha (Neb.) Gas Company into the city treasury, on account of the franchise agreement between it and the authorities for the year 1907, amounted to, $24,042.42, an increase of $3,019 over the sum paid on like account for 1906.

THE following is from the New Haven (Conn.) *Register* of recent date: "A distribution of stock allotted to certain employees of the New Haven Gas Company, under the terms of the profit-sharing plan put into effect by that Company April 1, 1907, was made the 11th inst., when 72 shares were turned over to the accounts of 53 employees of the Company. This distribution is made quarterly and the shares turned over to the Company's attaches this quarter were greater in number than at any other time since the plan was adopted. There are now 144 employees of the concern, excluding the executive officers, who hold one or more shares of the Company's stock, but there are 190 participating in the plan."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,

PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,

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NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Company, 39 and 41 Chambers street.
Germany—Lemcke & Buechner, of New York.
gland—Aug. Siegle, 30 Lime street, London.

MONDAY, JANUARY 27, 1908.

The Market for Gas Securities.

Consolidated gas opened at 100 and sold down to 98¼. The decline was in sympathy with the general market.

Brooklyn Union shows a decline of 3 points in the bid price.

The 5 million short time notes of the Consolidated Gas Company were quickly taken.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

JANUARY 27.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	98¼	99
Central Union Gas Co.—				
1st 5's, due 1972, J. & J	3,000,000	1,000	92	97
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual	3,500,000	100	—	170
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	85	90
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	98	104
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	90	98
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	100	105
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Standard	5,000,000	100	70	100
Preferred	5,000,000	100	100	125
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	90	100
1st Con. 5's, due 1948, M. & N.	15,000,000	—	91½	92
Yonkers	299,650	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	⅜	¾
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	500,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
" " Bonds, 5's	5,250,000	1,000	63	66
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,660,000	1,000	104	106¾
Cincinnati Gas and Electric Co.	29,500,000	100	92	92½
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	92	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	87	88
Preferred	3,026,500	100	107½	108
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	90
Mortgages, 6's	3,600,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Detroit City Gas Co.	6,000,000	50	—	50
" Prior Lien 5's	4,618,000	1,000	—	98
Detroit Gas Co., 5's	381,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Lt. Co., 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	100	105
" Bonds, 5's	10,500,000	—	101	102½
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	200,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	97	97¼
Preferred	2,500,000	100	93¾	93
Bonds	10,000,000	1,000	104	104¼
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	60	63½
Massachusetts Gas Companies, of Boston	25,000,000	100	53¾	54
Preferred	25,000,000	100	84½	84¾
Montreal, Canada	2,000,000	100	213	216¾
Nashville Gas Lt. Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	6,000,000	—	137	138
New Haven	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	85½	86
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Elec. Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104½	105½
San Francisco, Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	751,000	1,000	92	—
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	650,000	1,000	113	114
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,445,000	1,000	96¼	—
Syracuse, N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	102	—
Washington, D. C.	2,000,000	20	340	345
1st Mortgage, 6's	600,000	—	—	—
Western, Milwaukee	4,000,000	—	—	—
Wilmington, Del.	600,000	50	220	—

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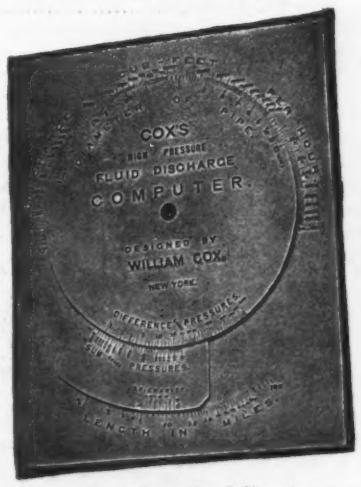

This Computer solves the following formula, which is applicable to Gas, Air and other elastic fluids, flowing through long pipes with high initial pressures:

Discharge in cubic feet per hour at atmospheric pressure $= 33.3 \sqrt{\frac{d^5 \times (p_1^2 - p_2^2)}{L \times w}}$

Where

d = diameter of pipe in inches,

p_1 = absolute initial pressure in pounds per square inch,

p_2 = absolute terminal pressure in pounds per square inch,

L = length of pipe in miles,

w = specific gravity of the fluid when air = 1.

To Find the Discharge from a Pipe and the Required Size of Pipe.

(1.) Set the specific gravity of the fluid opposite the length of pipe;

(2.) Bring the DIFFERENCE of the initial and terminal gauge pressures opposite the SUM of the initial and terminal gauge pressures;

(3.) Opposite any diameter of pipe will now be found the discharge in cubic feet per hour at atmospheric pressure; and

(4.) Opposite any desired discharge will also be found the required diameter of pipe.

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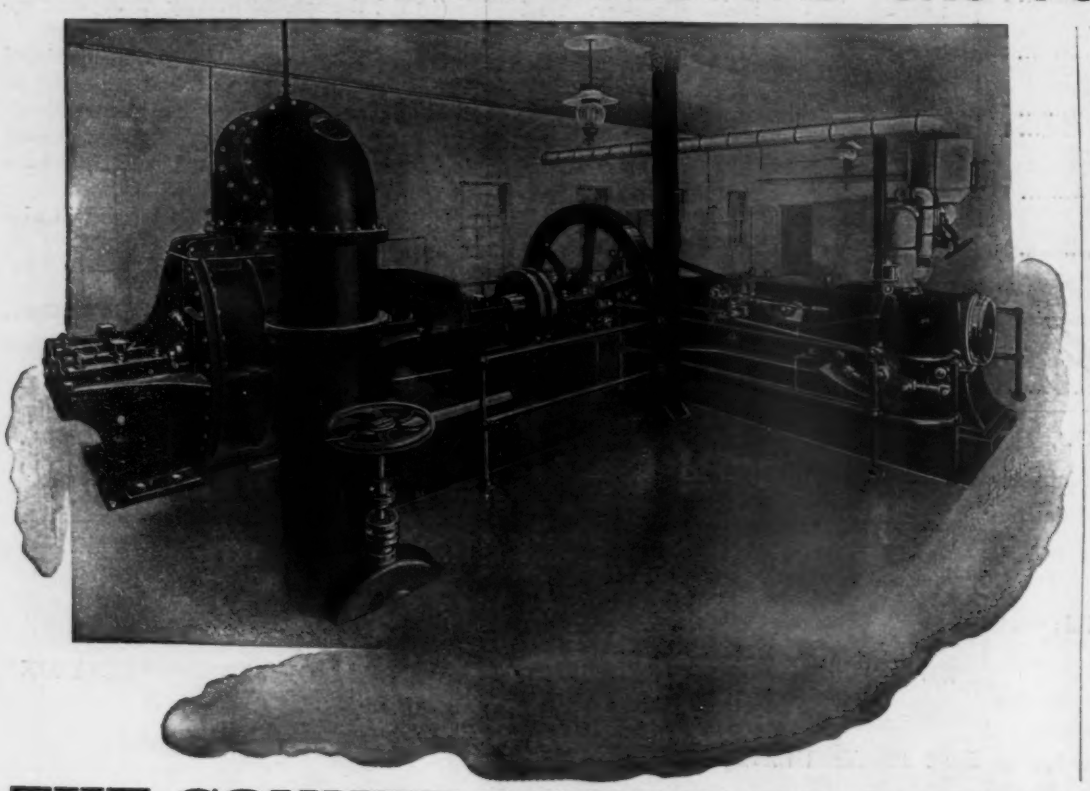

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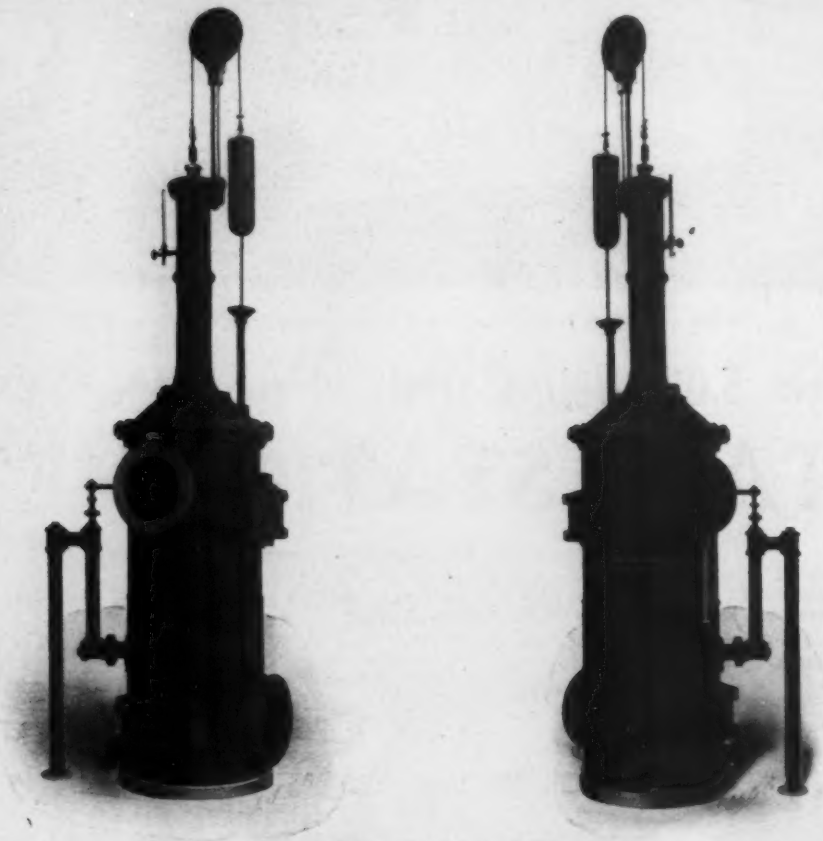

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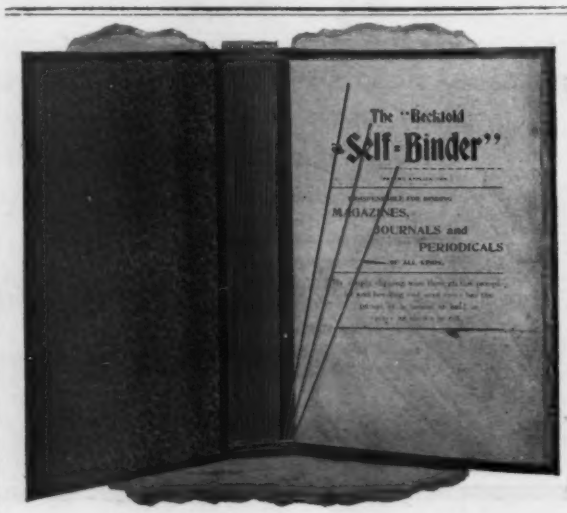

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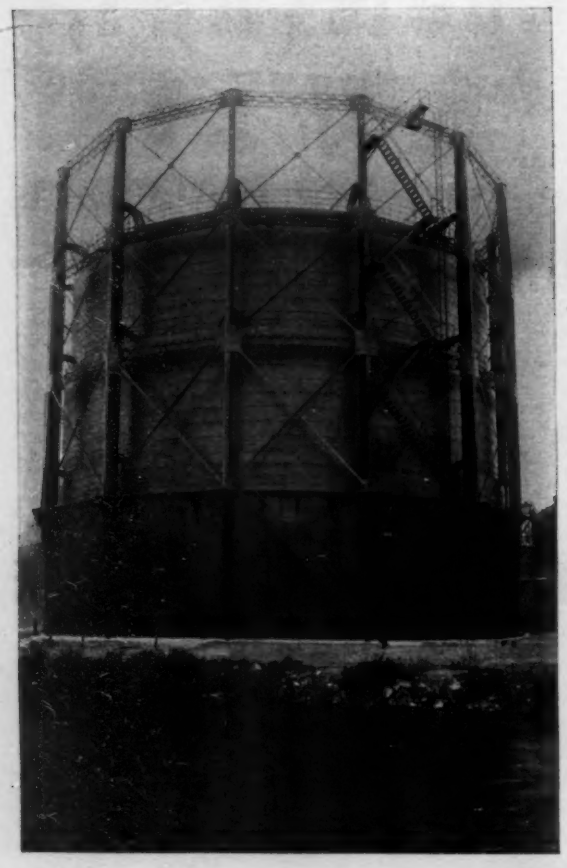

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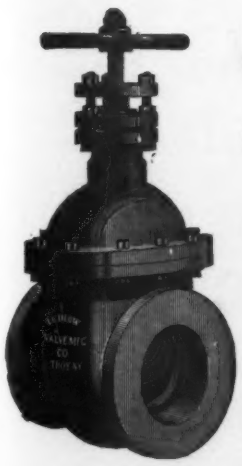

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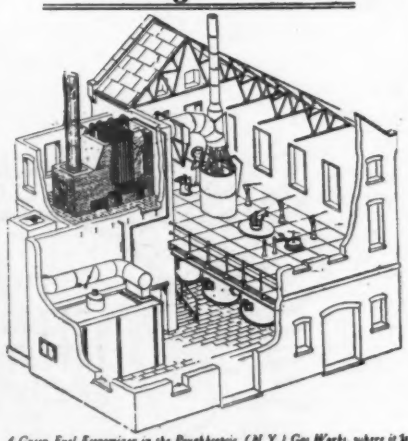

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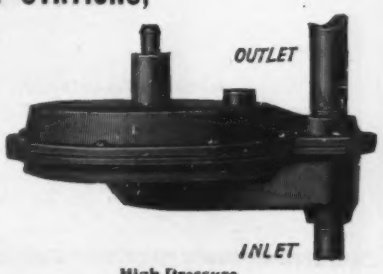

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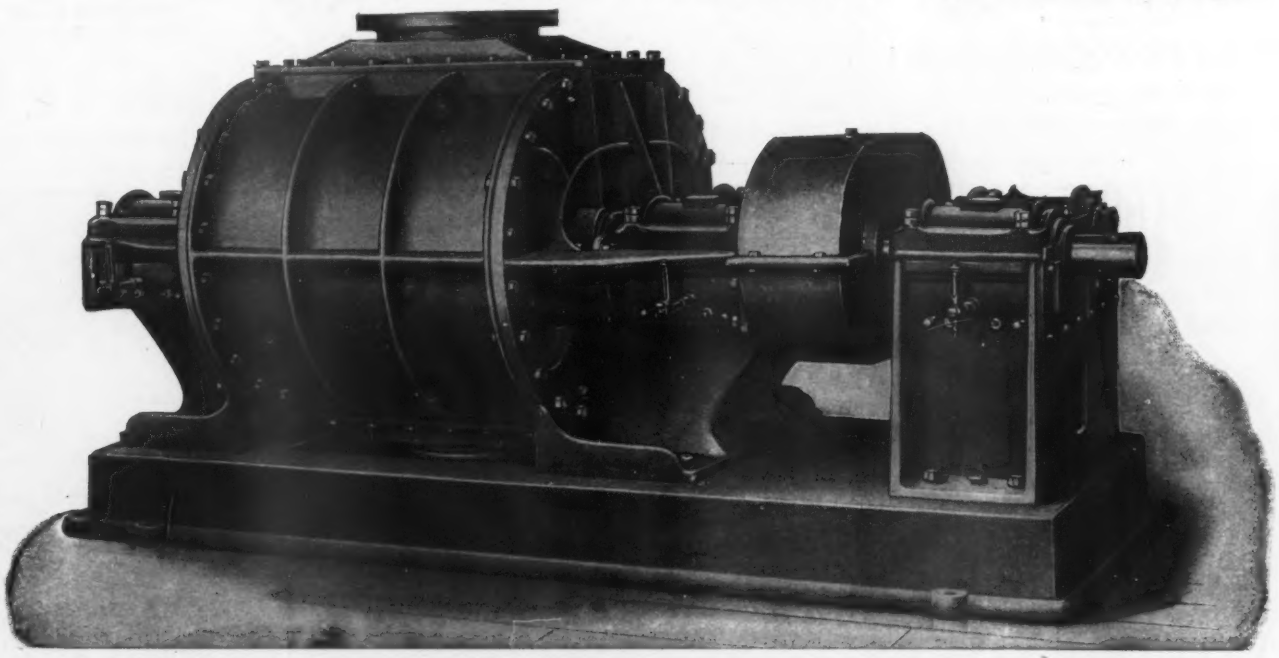

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PUBLIC LIGHTING TABLE.

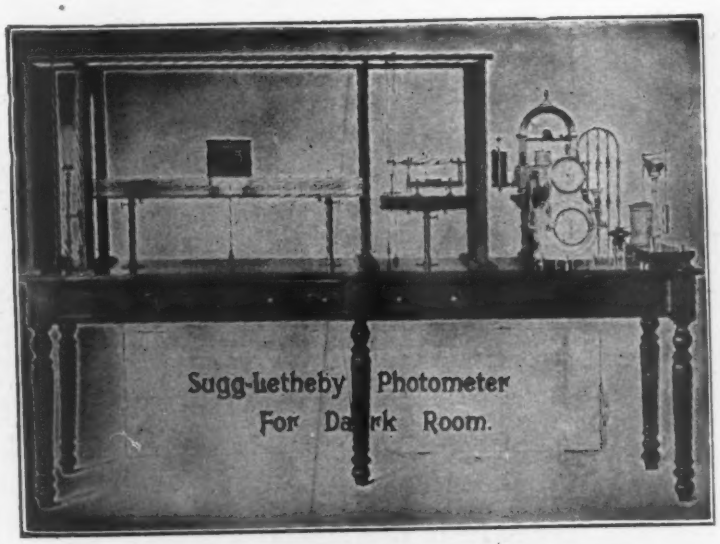
FEBRUARY, 1908.

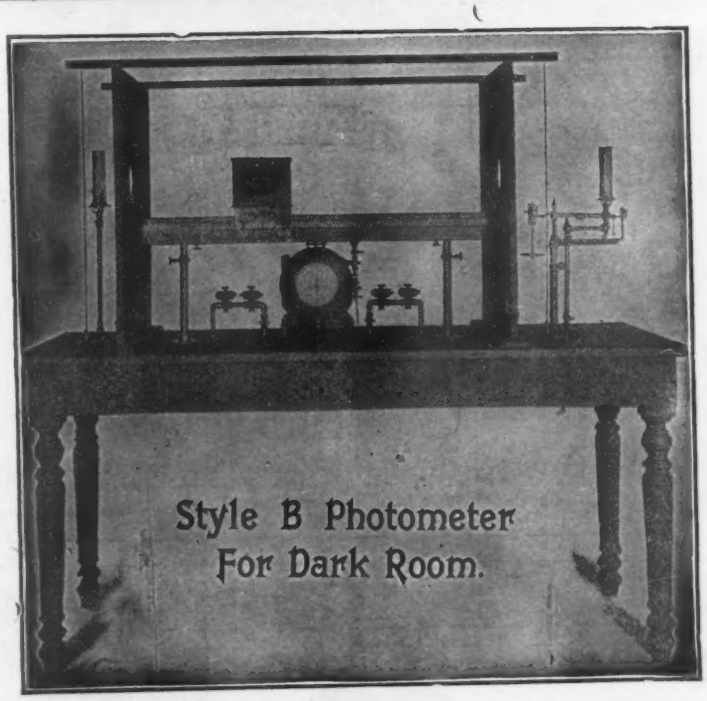
Day of Week.	Table No. 1. Following the Moon. Date.	Light.	Extinguish.
Sat.	1	5.40 PM	6.10 AM
Sun.	2	5.50	6.10
Mon.	3	5.50	6.10
Tue.	4	5.50	6.10
Wed.	5	5.50	6.10
Thu.	6	9.40	6.10
Fri.	7	10.40	6.10
Sat.	8	11.50 FQ	6.10
Sun.	9	12.50 AM	6.00
Mon.	10	1.50	6.00
Tue.	11	2.50	6.00
Wed.	12	3.40	6.00
Thu.	13	4.30	6.00
Fri.	14	5.10	6.00
Sat.	15	No L.	No L.
Sun.	16	No L. PM	No L.
Mon.	17	No L.	No L.
Tue.	18	6.10 PM	8.00 PM
Wed.	19	6.10	8.50
Thu.	20	6.10	9.50
Fri.	21	6.10	11.00
Sat.	22	6.10	12.00
Sun.	23	6.20	1.00 AM
Mon.	24	6.20 LQ	2.10
Tue.	25	6.20	3.20
Wed.	26	6.20	4.20
Thu.	27	6.20	5.30
Fri.	28	6.20	5.40
Sat.	29	6.20	5.40

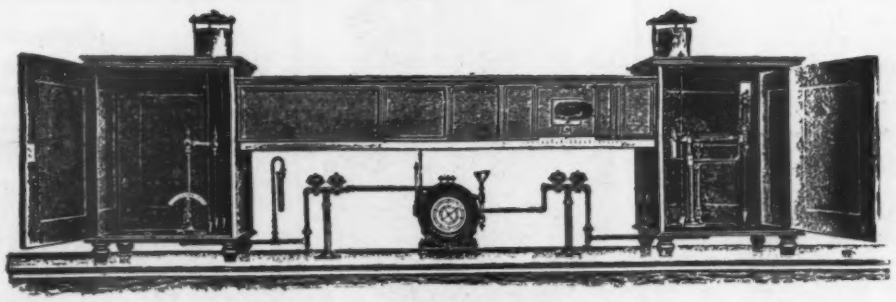
TOTAL HOURS DURING 1908.

By Table No. 1.

	Hrs. Min.
January	228.30
February	187.30
March	192.00
April	160.10
May	155.10
June	138.00
July	155.50
August	173.40
September	185.20
October	214.00
November	218.10
December	226.40
Total, yr.	2235.00







Closed Photometer For Light Room.

CIRCULARS SENT ON REQUEST.

PUBLIC LIGHTING TABLE.

FEBRUARY, 1908.

Day of Week.	Table No. 2. New York City. All Night Lighting. Date.	Complete Lighting in One Hour (From Time Given) P. M.	Complete Extinguishing in 50 Minutes (From Time Given) A. M.
Sat.	1	4.47	6.07
Sun.	2	4.47	6.07
Mon.	3	4.47	6.07
Tue.	4	4.47	6.07
Wed.	5	4.57	6.02
Thu.	6	4.57	6.02
Fri.	7	4.57	6.02
Sat.	8	4.57	6.02
Sun.	9	4.57	6.02
Mon.	10	4.57	6.02
Tue.	11	4.57	6.02
Wed.	12	5.07	5.57
Thu.	13	5.07	5.57
Fri.	14	5.07	5.57
Sat.	15	5.07	5.57
Sun.	16	5.07	5.52
Mon.	17	5.07	5.52
Tue.	18	5.07	5.52
Wed.	19	5.17	5.47
Thu.	20	5.17	5.47
Fri.	21	5.17	5.47
Sat.	22	5.17	5.47
Sun.	23	5.17	5.42
Mon.	24	5.17	5.42
Tue.	25	5.17	5.42
Wed.	26	5.22	5.32
Thu.	27	5.22	5.32
Fri.	28	5.22	5.32
Sat.	29	5.22	5.32

TOTAL HOURS DURING 1908.

	Hrs. Min.
January	481.50
February	329.15
March	351.50
April	341.50
May	233.05
June	218.10
July	282.55
August	254.55
September	292.25
October	420.45
November	374.30
December	411.05
	3992.35
Deduct on account of 50 min. extinguish'ng time	30.30
Total, yr.	3962.05

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Lowest Gas Consumption.
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Will Not Flash Back.
Will Not Blacken Mantles.
Will Not Discolor Fixtures.
Will Not Discolor Ceilings.

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Coney Island, N. Y.
Mexico, Mo.
Jacksonville, Fla.
Syracuse, N. Y. (2d contract).
Atlanta, Ga. (3d contract).
Holyoke, Mass.
Peoria, Ills.
Schnectady, N. Y. (2d contract).
Danbury, Conn.
Galveston, Tex. (2d contract).
Quebec, Canada.
Indianapolis, Ind. (2d contract).
Bessemer, Ala.
Waterbury, Conn. (5th contract).
Sioux Falls, S. D. (3d contract).
Philadelphia, Pa.

TOTAL SETS INSTALLED TO JULY 1, 1907,	34
TOTAL SETS TO DATE,	668
TOTAL DAILY CAPACITY,	541,655,000 cu. ft.

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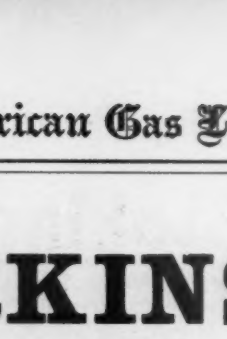

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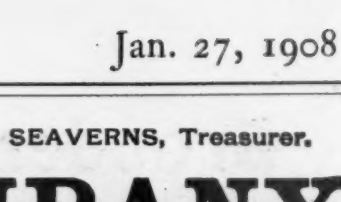

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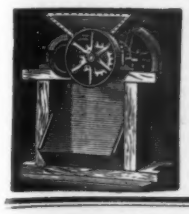

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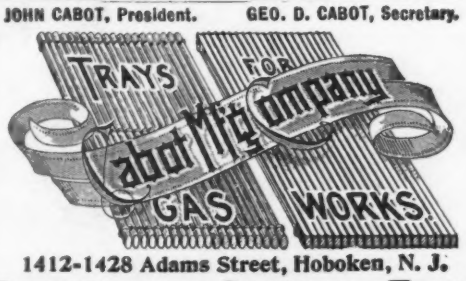

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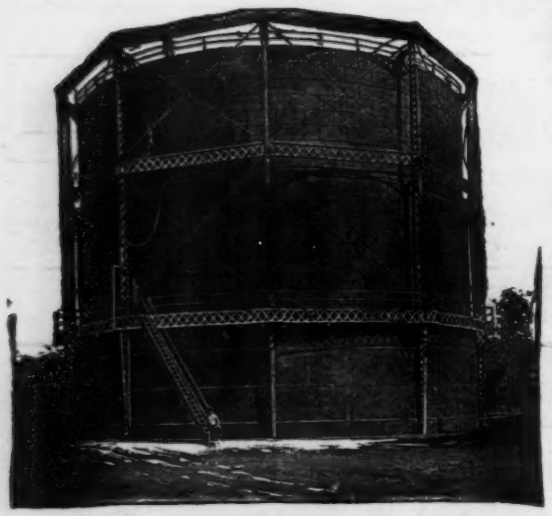

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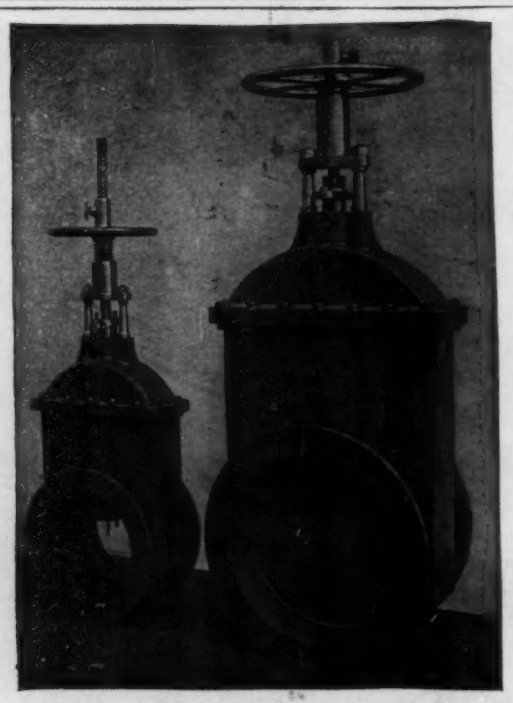

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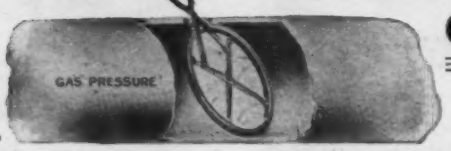

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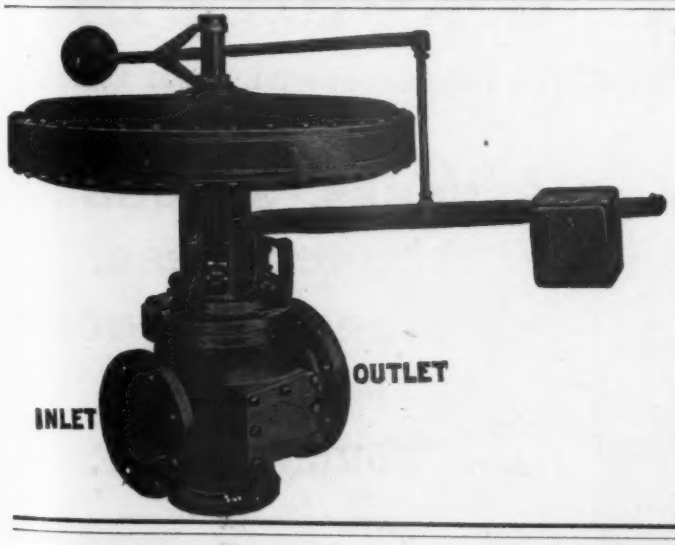

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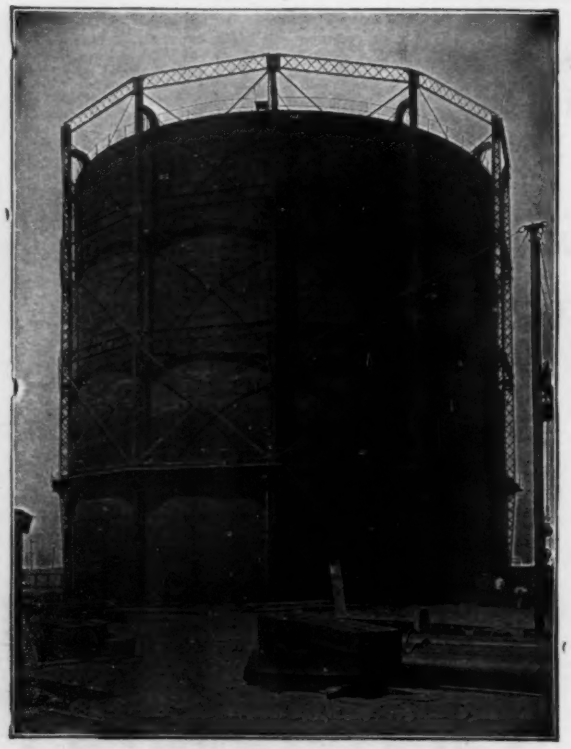

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